Large IT Projects as Interventions in Digital Ecosystems

Sandeep Purao  
Associate Professor  
College of IST  
Penn State University  
001 814 863 0017  
spurao@ist.psu.edu

Kevin Desouza  
Associate Professor  
School of Information  
University of Washington  
001 206 616 0880  
kev.desouza@gmail.com

ABSTRACT
Large IT projects, such as the US Government’s Internal Revenue Service Business Modernization Effort, can take a decade or more and consume billions of dollars. Traditional approaches to the study of such projects emphasize concerns such as monitoring requirements and tracking progress. We propose an alternative approach guided by a digital ecosystems view instead of a hierarchical, decision-oriented view. We argue that a digital ecosystem perspective is more suited to understand how such projects evolve and cause changes in the underlying digital ecosystem characterized by not only the IT infrastructure but also the transactional relationships among stakeholders. We illustrate our arguments by drawing on an archaeological case study of the IRS effort, and discuss implications of the digital ecosystem perspective for the study of large IT projects.

Categories and Subject Descriptors
K.6.1 [Project and People Management]: Life cycle, Strategic information systems planning. J.4 [SOCIAL AND BEHAVIORAL SCIENCES]: Psychology

General Terms
Management, Documentation, Design, Experimentation, Theory.

Keywords
Ecosystem, Large IT projects, Longitudinal analyses, Secondary data, Case Study, IRS.

1. INTRODUCTION
An ecosystem consists of a number of organisms in an environment that interact not only with one another as well as with the environment in an ongoing exchange of matter and energy [29]. Macro-level properties such as self-organization, scalability and sustainability characterize an ecosystem [17]. For example, as actors are introduced in an ecosystem, they may assume roles and adapt to enter into transactional relationships with existing actors. New generations of species can result either in creation or consumption of resources that other species can adapt to. A digital ecosystem borrows these concepts to emphasize the adaptive and open nature of ecosystems that rely on IT infrastructures [1]. In particular, it recognizes that the underlying IT infrastructure facilitates the complex transactional relationships among participants in the ecosystem. A large IT project resembles a new influence on this digital ecosystem. It changes not only the IT infrastructure but can redefine existing transactional relationships among the community of stakeholders. Large IT projects (such as the Business Systems Modernization project at the IRS) can consume significant resources (USD 3 billion over several years) making such investigations critical. They represent one significant case that exemplifies the sub-par record of IT project failures. We argue that this, digital ecosystem, perspective is more useful and appropriate (than the traditional, control-oriented perspective) to understand how large IT projects evolve. It recognizes the inherently emergent changes that may be caused by such projects. In this paper, we outline our argument and illustrate some of its implications with the help of a case study.

The rest of the paper is organized as follows. In §2, we introduce the ecosystem perspective. In §3 a brief overview of the IRS Business System Modernization (BSM) project is presented. Following this, we outline our research approach in §4. Our analysis and results are presented next in §5, followed by our conclusions are areas for future research in §6.

2. (DIGITAL) ECOSYSTEMS
Tansley [29] defines an ecosystem as an integrated and interactive system comprising of abiotic and biotic components. These components include a number of species, food sources and modes of interaction. The species may be predators or prey, may exist parasitically or symbiotically, and in different habitats. However, they co-exist in a balanced state within the ecosystem [26]. The ecosystem perspective emphasizes the intimate and continual relationships living organisms have with other elements in the environment. These interactions may be permanent or direct, but may also happen in an ad-hoc or dynamic manner, and may even occur indirectly, via secondary connections. The interactions ensure that no organism operates in isolation. Success or failure of an organism is determined by how well it adapts to, and thrives in, the environment, which in turn is influenced by other species in the environment and how the organism interacts with, and influences the other species and the overall environment. A stable natural or artificial ecosystem develops over time. Time helps in the formation of relationships,
expectations, and habitations of species within the ecosystem. Similarly, in artificial (digital) ecosystems, we see the emergence of patterns over time in a wide assortment of elements from norms, to usage patterns (i.e. variability of demand and loads), and spheres of influence, among others.

When a stable ecosystem is invaded externally, through the introduction of foreign objects or agents, the ecosystem perceives shocks. Depending on the scale of the shock, the ecosystem may go through small periods of adjustments, or may become unstable. Consider a technical system that is stable, and then has to be integrated with another system or has to now process new sets of data, etc. The system will either go through small modifications (incremental innovations) or in some cases may need to be completed obliterated (for radical innovation). What is interesting here is that just like a natural ecosystem will never revert back to its original state, similarly it is hard to reverse changes to a digital ecosystem. A disruption to the ecosystem may bring about changes such as more resources or more efficient modes of interaction. It may also endanger the habitat of some species, or make some predators more effective. In all cases, it can affect the existing balance among species and challenge the stability and sustainability of the ecosystem by threatening the diversity and productive capacity of species.

A study of (digital) ecosystems often requires paying attention to the boundaries. This is determined by the notions of bioocoenosis (the entirety of life) and biotope (the medium that life exists in). Bioocoenosis emphasizes the interrelationship among species, whereas Biotope defines the space or location that provides the field where these relationships play out. For example, one can study micro-ecosystems that reside within other, larger meso ecosystem (e.g. trees could belong to the meso system of forest). By outlining the biotope, one can decide the scope of study. For a digital ecosystem, the study can, therefore, focus on units of different sizes such as groups, organizations, inter-organizations, and society at-large. The specific sub-discipline of community ecology (synecology) allows greater specification of this scope because it is concerned with the examination of how species interact within a given ecological community. It emphasizes the study of community influences and interactions among species.

These concepts are useful for the study organizations (socio-technical systems), which can be considered stable if we see evidence of the following: clear mission and objectives, established roles for members, stable and reliable communication protocols, a stable technical infrastructure, established patterns of interactions with the external environment, and presence of a sustainable business model. An environment, from the macro-perspective, can be viewed as a collection of organizations and the interaction patterns among the organizations. We can view organizations as species that interact to achieve desirable outcomes. Organizations may mature and grow if they are able to adapt to changes in the environment and have competitive capacity, or alternatively, they may wither and die.

Several concepts outlined above provide a useful perspective to study digital ecosystems. A digital ecosystem contains digital and human components, broadly corresponding to the abiotic and biotic components in an ecosystem. The ecosystem view for studying these environments and organisms living in these environments provides a clear alternative to the classic, control-oriented perspective. It questions the premise of an abstract, mathematical model of nature that builds on the assumption that elements and their properties are homogeneous, and that there are predictable dependencies among the elements. The next section describes a case study that explores the usefulness of studying large IT projects as interventions in a digital ecosystem.

3. THE CASE STUDY

3.1 The BSM Project

The Business Systems Modernization (BSM) project at the US Government Internal Revenue Service was initiated in response to The Internal Revenue Service (IRS) Restructuring Reform Act of 1998 [25]. The law required the IRS, among other things, to restructure itself to better serve taxpayers and mandated that the IRS improve its systems for this purpose [33]. The program was considered inherently important to IRS because of its close association to the IRS’s stated mission: “provide America’s taxpayers top quality service by helping them understand and meet their tax responsibilities and by applying the tax law with integrity and fairness to all” [15].

3.2 Project Progress

The mandate for systems modernization leads to the first contract that the IRS entered into with Computer Sciences Corporation (CSC). CSC was charged with assembling a team of contractors, known as the PRIME Alliance, to develop new systems for the IRS to achieve modernization [35, 14]. The IRS also created a Business Systems Modernization (BSM) Office that was charged with leading the IRS’s acquisition and implementation of new technology [35]. These actions kicked off the Business Systems Modernization (BSM) program. The IRS originally expected the BSM program to cost $8 billion over a fifteen-year period [23]. The actual cumulative amount of funding spent on the program to date is nearing USD 3 billion [23]. Since its inception, the BSM program has been threatened by delays, scope reductions, funding reductions, and poor costing [4, 5, 6, 7, 9, 10, 11, 12, 13, 35]. After several years of efforts, based on status reports in 2007 [22] several systems considered a part of the BSM program remain incomplete and behind schedule.

3.3 Leadership

During the time that the BSM project has been under-way, the central organization, IRS, has seen several leadership changes. Not only has the incumbent CIO role changed hands, the IRS Commissioner has changed as well. In December 2006, a new role was introduced in the form of a CTO. Table 1 outlines these changes in the BSM Project Leadership.

<table>
<thead>
<tr>
<th>Year</th>
<th>Commissioner</th>
<th>CIO</th>
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<tbody>
<tr>
<td>1999</td>
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<tr>
<td>2007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>Douglas Shulman</td>
<td>Art Gonzales;</td>
</tr>
</tbody>
</table>
3.4 Stakeholders
As a complex effort, the BSM project involved not just the IRS itself but also several other external and internal stakeholders. Table 2 lists key stakeholders.

Table 2. Key Stakeholders in the IRS BSM Project

<table>
<thead>
<tr>
<th>External Stakeholders</th>
<th>Internal Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The Treasury Department</td>
<td>• Senior Management</td>
</tr>
<tr>
<td>• The US Congress</td>
<td>• Taxpayer Divisions</td>
</tr>
<tr>
<td>• The General Accounting Office (GAO)</td>
<td>• The Internal IT Organization</td>
</tr>
<tr>
<td>• Contractor</td>
<td>• Contractor</td>
</tr>
<tr>
<td>• Taxpayers</td>
<td>• Taxpayers</td>
</tr>
</tbody>
</table>

More details about these stakeholders and their specific roles and mandates are elaborated elsewhere [24].

3.5 Continuing Challenges
The scale, number of stakeholders and ongoing challenges highlight the complexity of the IRS BSM project and underscores key challenges identified by Treasury Inspector General for Tax Administration (TIGTA). Table 3 outlines these based on the TIGTA report from 2009.

Table 3. BSM Program: Key Challenges (see [23])

• Development of long-term systems requirements
• Weaknesses in program and contract management
• Problems with security controls
• Difficulties in obtaining qualified personnel and funding.

The challenges outlined are, however, not unique. They reflect what has been known in prior research related to software engineering and project management elsewhere, i.e., the BSM case provides a prototypical example of problems faced by large IT projects.

Our efforts in this research were, therefore, aimed at improving our understanding of these problems. In particular, we are interested in understanding how the timeline and behaviors of different stakeholders may be interpreted following the ecosystem perspective.

4. RESEARCH APPROACH
The overall research approach we followed was a case study [36] that relied on archaeological analysis of publicly available data from different stakeholders.

4.1 Data Collection
The data for the case study was collected by systematically locating and acquiring documents (such as press releases, audit reports and the like) created by stakeholders in the BSM program. As in other studies focusing on analysis of historical documents (e.g. [30]), we acknowledge that these documents may not reveal the stakeholders’ personal agendas, the full nature of interpersonal communication, compromises incentives or secret caucus results. Others who study historical organizational processes express similar caveats (see, e.g. [20]). Table 4 lists the sources, which were utilized for obtaining these documents.

Table 4. Sources of Secondary Data

<table>
<thead>
<tr>
<th>Source</th>
<th>Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIGTA</td>
<td>48</td>
</tr>
<tr>
<td>GAO</td>
<td>43</td>
</tr>
<tr>
<td>CSC</td>
<td>9</td>
</tr>
<tr>
<td>Government Computer News</td>
<td>169</td>
</tr>
<tr>
<td>Accounting Web</td>
<td>6</td>
</tr>
<tr>
<td>GovExec / NextGov</td>
<td>28</td>
</tr>
<tr>
<td>IRS Press Release</td>
<td>10</td>
</tr>
<tr>
<td>Washington Technology</td>
<td>32</td>
</tr>
</tbody>
</table>

4.2 Research Techniques
These, publicly available documents, describe how the different stakeholders reflected on project progress and their own role in the re-architecting effort. The corpus of text available from these documents is associated with stakeholders and a timeline. The simple meta-model outlined in Figure 1 suggests the categories available for analysis of data.

Figure 1. A Nominal Meta-Model for Data Analysis

The data can be analyzed with the help of process tracing, event analysis, and analyses of the corpus of text contained in the documents. The data was analyzed through multiple passes of reading and interpretation as well as quantitative techniques. We describe here one specific technique we used for analyzing the text contained in the documents.

This specific technique was Sentiment and Confidence Analysis (see [34]). Sentiment analysis computes the strength of sentiment expressed in a document by analyzing the content in the document. A number of specific techniques have been proposed for sentiment analysis (see a useful compilation at http://www.cs.cmu.edu/~wcohen/10-802/fixed/Main_Page.html). For the purpose of post-fact historical analysis, and analyzing trends, minimal techniques were considered adequate. The list of tags used for these analyses was obtained from the General Inquirer set of tags and enhanced for the purpose of this analysis. These tags are commonly used words in English that, if present in a document, likely indicate the tone of the document. For example, the presence of certain words may suggest that the tone of the document is positive or negative.
The intended analysis for each document was meant to produce a placement for each document in a two-dimensional space along the two dimensions of Confidence and Sentiment. For example, we might expect that a Report from the Prime Contractor may appear as Positive Understated if the Prime Contractor follows the strategy of promising low and delivering high. On the other hand, an audit report may be cautious and may highlight negatives, suggesting a placement in the Negative Overstated quadrant. Over time, the placement of each document in the quadrants would then reveal the trajectory of progress. Seeing the trajectory from the perspective of different stakeholders would allow an analysis of how each saw its own participation in the project and assessed project progress.

A corpus of text was constructed based on the documents. For each document, the text tokens were extracted using simple text processing mechanisms. A database structure provided the ability to navigate and search the corpus. The set of tokens produced for each document was then used to compute the above measures by exporting the data in a spreadsheet. Additional details of the technique and measures used for the analysis are available elsewhere [24].

5. ANALYSES AND INTERPRETATIONS

5.1 Characterizing the BSM Project

A large IT project is often described as designing a solution. A key feature of such a solution is, then, the integrity of the designed system's boundaries [27]. Once implemented, the design is seen as closed to material and energy flows not accounted for in the initial envisioning process. This, more conventional, practice, marginalizes or even excludes parameters that do not lend themselves to high levels of control during the design-build process that is part of a large IT project [28]. This perspective suggests a reductionist view where the properties and behaviors of parts are controlled to provide needed human benefits [8].

In contrast, the study of the BSM project showed that for a large IT project, the design involved more than the envisioning, implementation and deployment of a technological solution. Instead, the exercise involved several organizations who were asked to come together and collaborate. The resulting activity produced a shock to the existing environment. For the BSM case, the environment can be described in both logical (as in a collection of species) and physical (as in an actual geographic environment) terms. For example, in terms of a logical environment, the project may move an organization from one environment (e.g., market) to another, or at the minimum lowering its focus from one area to another. This may impact a stakeholder’s ability to survive. In terms of physical environments, introduction of an IT solution will change the patterns of interaction among the species.

Characterizing large IT projects as the cause of changes in interaction patterns (that is, as an intervention in an ecosystem) involves holistic arguments. Although these arguments tend to be appealing, they can be difficult to research because their operationalization often leads to the fallacy of using reductionist concepts [17]. The digital ecosystem perspective can provide additional avenues to analyze successes and failures in large IT projects. As an example, macroscopic concepts used to understand and appreciate properties and aspects of an ecosystem may include environ, ascendency, exergy and emergy [8]. The first refers to the environment, the abiotic components, that support the webs of relationships among the biotic components. The second, ascendency, refers to resiliency of the ecosystem. It captures the ability of the ecosystem to withstand shocks and disturbances due to its size and organization. An ecosystem with a higher ascendency index can render the intended outcome of a large IT project ineffective by persisting with the established network of relationships within the ecosystem. The third, exergy, quantifies the work possible during a process that brings the system into equilibrium. It is, in effect, energy that is available to be used. A large IT project may contain exergy that can dissipate over time as it engages with the ecosystem it tries to change. As exergy is destroyed, it increases the entropy, diminishing the possibility that the change intended by the IT project will be effected. The final concept, emergy, describes a measure of the energy that has contributed to creating an outcome. This concept is important because it can describe, in a retrospective manner, how much energy would be necessary to effect a similar change, if similar conditions prevail.

5.2 Explaining BSM Project Outcomes

In contrast to the macro-level concepts, the micro-level concepts provide greater access for operationalizing the constructs and explaining the project outcomes. Many of these capture the relationships among participants within the ecosystem. In an ecosystem, each element influences and is influenced by others. These systemic interactions allow the elements to co-adapt to each other and to their environment to actively construct their particular niches [17]. For example, a large IT project, as it tries to bring about a change in the ecosystem, may find it more beneficial to interact with multiple participants, design new interaction protocols, and suggest abandoning old ones. The relationships that may be considered for such analysis include intraspecific (among individuals of the same species) and interspecific (across species), and may be characterized as mutualism or competition [2]. More specific forms that represent specializations of these relationship types can include arrangements such as co-habitation (a form of mutualism), avoidance, predator-prey, and several others [2]. Few explanations are available to understand how these relationships are introduced, how old ones are abandoned, and how they are propagated through remaining parts of the ecosystem [3]. This is particularly true in the context of large IT projects as well. A succinct and complete conceptual framework for control and governance in an ecosystem remains elusive although some possibilities have been proposed, extending traditional food web models [19]. Events that make the ecology unstable may also be identified such as (a) the introduction of invasive species (e.g., consultants for a large IT project), (b) habitat loss (e.g., inaccessible resources due to process changes following an IT intervention), (c) keystone species decline at an unsustainable rate (e.g. loss of key knowledge workers in an IT project), (d) extinction (e.g. due to job losses and inability for the species to adapt and find new sources of energy), and (e) climate change (greater competition, greater regulation, etc). A large IT project may (intentionally or inadvertently) inject one or more of these shocks in an ecosystem.

5.2.1 Keystone Species

In the case of the BSM project, one such event that can be identified was poor management of keystone species. These can be conceptualized as the individuals assuming the CIO and
Commissioner roles. Table 1 earlier documents the turnover in these roles during the duration of the project so far. The conventional interpretation of these events emphasizes loss of knowledge. We suggest that endangering keystone species in an ecosystem may be a more apt interpretation for such events. As the table shows, the turnover also resulted in several gaps where the positions were vacant, that is, the keystone species in the ecosystem was, in fact, not functioning.

5.2.2 Competing Ecosystem Engineers
A second interesting observation based on the data was that there were competing ecosystem engineers. Ecosystem engineers are species that build or make fundamental change to the environment. In most cases, these species make changes for the benefit of other species; however, sometimes, the intended outcomes may not be materialized leading to outcomes that are detrimental. In the context of the BSM case, competing ecosystem engineer roles were assumed by IRS senior management, by CSC as the Prime Alliance, and by the US Congress by passing bills with specific mandates. The idea of dominant design was therefore, a contested space with each ecosystem engineer trying to impose their design.

5.2.3 Threatened symbiotic relationships
A third area where ecosystem concepts were vital in understanding project progress was the symbiotic relationships that exist between species. Symbiotic relationships are mutually beneficial (or in a worst case scenarios, beneficial to one and neutral to the other) to both parties. It is through repeated interactions and exchanges (i.e. over time) that two species will develop a symbiotic relationship. Failure to arrive at a symbiotic relationship will undermine the collaboration (and co-existence) between the species. Inception of the BSM project threatened existing symbiotic relationships because different species needed to reorient their current portfolio of alliances. The success of the BSM project can be considered a function of how well these relationships are re-aligned to minimize damage to species under the given time constraint. The data gathered from the BSM project showed that the perceptions from each species (stakeholder) were a little different in terms of their belief in project progress and confidence in reaching the goals (see more detailed analysis elsewhere (Purao and Desouza 2010)).

The distinction between local versus global view of relationships suggests yet another interesting challenge for studying large IT projects following the ecosystem perspective. Each species will clearly have only a local view of its relationships and will engage in local optimization. How these local optimization efforts can be reconciled, rolled up and integrated at the level of the ecosystem remains a critical pre-requisite for successful completion of the project. In the BSM case, this can be achieved by examining the recruitment of initial partners in the Prime Alliance by CSC, followed by how these relationships evolved as dyads. The nature of their evolution through different stages is difficult to discern from the documents contained (e.g. as symbiotic or parasitic relationships). It is, however, possible to infer some of these by examining changes in the attitudes and perceptions of the different stakeholders. For example, our analysis of the data [24] shows that the Prime Alliance expressed much greater confidence in project progress. The evolution of relationships from symbiotic (say, before the inception of the BSM effort) to parasitic relationships is a more difficult change to discern. For the BSM project, this was not apparent. If a particular species is threatened, this may manifest as extinction of some species, which in turn threatens any species relying on them.

5.2.4 Ecological Niches
A fourth concept implicated in our analysis was that of ecological niches. Ecological niches are territories or specific food sources consumed by species that are not in competition with other species. These can be thought of as competitive advantages or even market niches. These niches take time and energy to develop and in many cases cannot be easily substituted (similar to organizations that develop distinctive capabilities that help them compete and survive in environments). The BSM project can be seen as eroding existing niches and even forcing organizations to compete or collaborate for new niches. A related concept is that of habitat loss, for example, due to urbanization. Once habitats are lost, species are displaced and have to learn about, and survive in, the new environments. LsPsP do end up destroying existing habitats. For the BSM project, which was largely focused on making more efficient the functions that each stakeholder was meant to perform, this habitat loss was not immediately apparent. However, our analysis did not include investigation of the specific processes that were revamped or changed. It is conceivable that dis-intermediation could have led to such loss of ecological niche for internal stakeholders. The sentiment analysis results based on analysis of documents [24] suggested that such negative sentiment was missing among the stakeholders.

5.2.5 Speciation
The next concept of interest for the BSM project was speciation. Speciation refers to the formation of new species from old ones; either due to natural evolution or artificially through breeding. In terms of the digital ecosystem disturbed by the BSM project, this can be seen in terms of how the BSM project may have lead to mergers, collaborations, and even the creation of new roles and organizations. One specific outcome that was immediately evident in this regard was the new role of a CTO that specialized some of the functions originally performed by the CIO. After nine years, in December 2006, this new role was introduced by the BSM project. Another possible manifestation of this concept could be the deliberate alliance of contractors with CSC. It would, however, be difficult to understand the motives that lead to these outcomes based on an examination of the documents.

5.2.6 Invasive or New Species
The final set of concepts from the ecosystem perspective that were considered during the analysis viewed the BSM project itself as a new species with a view to examining how it competed with other projects, both IS and non-IS, within the IRS. Here one possible lens would be that of invasive species (species added to an ecosystem in an unnatural way). The native species (the traditional projects) will face competition from the invasive species, and may not be able to survive, due to competition for food and shelter (resources) from invasive species. It may be possible to explore the possibility of treating external consultants as invasive species. The documents available for the BSM project, however, did not allow such a conclusion based on prima facie analysis.

The analyses above were the result of applying informal as well as formal techniques that analyzed the content in the publicly available documents for the BSM project.
5.3 Exploring Stakeholder Sentiments

The corpus of text constructed from the documents was also analyzed and trends for stakeholder sentiments were plotted. To do this, two measures were devised. These are described elsewhere in more detail [24]. Here, we outline the measures to allow the readers to make sense of the outcomes. The first, Confidence, computed the relative confidence (Overstated vs. Understated words) in each document: Confidence = (# Net Tokens that are Overstated) / (# Tokens). A corresponding measure was developed to compute relative sentiment (Positive vs. Negative words) in each document: Sentiment = (# Net Tokens that are Positive) / (# Tokens). In both cases, in spite of the possibility of some loss of data, the net occurrence of Overstated versus Understated or Positive versus Negative words was computed. For example, a document containing 15 occurrences of Positive words and 3 occurrences of Negative words would yield a numerator of 12; the total number of tokens in the document would yield the denominator (e.g. 300); and the measure would be computed as a fraction, in this case, 4%. Instead of analyzing different stakeholder sentiments (see [24]), this paper tries to treat reports from Government Computer News as omniscient reports that provide an overview of the progress of the BSM project. These reports are, thus, seen as reports on the health of the ecosystem. Figure 2 shows this longitudinal analysis.

![Figure 2. Longitudinal Sentiment and Confidence Analysis for Reports from Government Computer News](image)

The figure shows the Sentiment measure marked by a solid line and the Confidence measure marked by a dotted line. We highlight three incidents from the figure. The first (marked by the number 1), fairly early in the project cycle shows a Positive Sentiment expressed with not very high levels of confidence. The second appears soon after the onset of the project (marked by the number 2) that shows the Sentiment plummeting with equally low confidence. This is followed by a relatively long period of positive Sentiment accompanied by negative Confidence. The final period (marked by number 3) appears later in the lifecycle and is once again marked by low values for both Sentiment and Confidence. This view can be a useful indicator for the overall health of the ecosystem as seen by an omniscient observer (in the case of BSM, the Government Computer News).

The stakeholder sentiment analysis provides an additional avenue to explore how the digital ecosystem perspective may help explain large scale IT projects. The longitudinal sentiment analysis can be seen as (a) providing indicators that should be explored more to arrive at an understanding of reasons, or (b) as additional evidence that can provide greater confidence in the interpretations such as those reported in the previous section. Consider, for example, the period marked by number 3 in the figure. This may prompt an investigation into reasons, which may, in turn, lead to discovery of underlying causes such as threatened symbiotic relationships (§ 5.2.3) or habitat loss (§ 5.2.4). In the case of the BSM project, this may be discovered in terms of relationships between the Prime Contractor and others or in terms of dis-intermediation and process loss that lead to loss of niche power for some internal stakeholders.

6. CONCLUDING REMARKS

The analyses and interpretations described in this paper are clearly preliminary. However, they have the benefit of significant empirical basis. Our intent in the paper has not been one of prediction. Instead, we are interested in demonstrating how the ecosystem perspective can be used to better understand the evolution of large IT projects like the BSM Effort. The interpretations based on the ecosystem perspective acknowledge that large IT projects cannot be treated as controllable efforts. Instead, an emergent perspective that recognizes the diverse actions of different stakeholders and how they need to be managed in the environment is likely to be more appropriate. A significant problem with the use of ecosystem perspectives for the study of large phenomena is that sometimes, the holistic arguments tend to be easier to make difficult to demonstrate or substantiate in specific contexts. In the examples we have shown, we have attempted to overcome this limitation by relying on historical and longitudinal data.

The (digital) ecosystem perspective however is no panacea for analyzing LsPsP. Like other theoretical perspectives it has its own limitations. First, the ecosystem perspective can become unwieldy to study if we have a large number of stakeholders and a multitude of interaction sets. Second, the success of applying the ecosystem perspective, as applied to the study of IT projects, is heavily dependent on clear specification of the unit of analysis. In our study, the unit of analysis was the BSM project. The focus on the BSM calls for studying interaction of stakeholders around the BSM project, and ignoring other interactions. In reality, there might be other critical, and influencing, interactions that do not involve the BSM project. For example, CSC’s involvement in other government contracts beyond the IRS and its performance may be discovered in terms of relationships between the Prime Contractor and others or in terms of dis-intermediation and process loss that lead to loss of niche power for some internal stakeholders.

The implications for further research are several. The analyses and interpretations we have suggested can form the basis of additional investigations. Specific techniques may be employed for the purpose of these investigations including event and process analyses as well as more sophisticated lexical analyses. The interpretations also allow potential insights into how risks might
emerge in large IT projects, and how they may be detected. Other possible uses of the perspective include the ability to detect and encourage dyads or other networks that overcome possible undesirable consequences such as habitat loss or invasive species, and encourage symbiotic relationships.

7. ACKNOWLEDGMENTS
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8. REFERENCES


