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Sustainable benefits of IT investments:
From concept to implementation

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ABSTRACT
Information technology (IT) benefits are often indirect and are not easy to demonstrate. Often the problem associated with IT investments magnifies because IT-enabled benefits tend to dissipate over time. In this paper we develop the concept of sustainable IT-enabled benefits. First we develop the concept of sustainability as it applies to IT. Following that, we base our conceptual framework to sustainability as a response to the process paradox (Keen, 1997) and the improvement paradox (Repenning and Sterman, 2001). We argue that organizational and IT processes change. These changes in processes have a direct impact on the maturity of processes. Changes can be planned (for instance, process improvement activities in the organization) or unplanned and even unobserved (like changes due to organizational and external changes anyway). We argue that organizational and technical flexibility is a critical enabling factor for sustaining IT-enabled benefits. This sustainability is manifested primarily through flexible processes. However, in experiencing such sustained benefits, clarity of objectives has to be defined as the explicit dual of flexibility. Meaningful and unambiguous standards provide the requisite practical complement to the conceptual notion of flexibility. We end this paper by providing implications of this approach for ongoing research for IT effectiveness and for practitioners.

Keywords
Information technology, sustainable benefits, process, improvement paradox, process paradox.

INTRODUCTION
The importance of the concept of sustainability to the field of information systems (IS) is becoming increasingly relevant. The concept of sustainability is applicable at various levels of abstraction and to different concepts. The notion of sustainability assumes importance because of the changes that take place due to IT and in the technologies themselves. Practitioners and researchers have started to look for sustainable IT-enabled change because while IT does induce change (most of it expected; and some of it unanticipated), the rate of change and the expected benefits do not, at times, last as long as expected.

The concept of sustainability is complex and lends itself to interpretation. Some authors like Gladwin et al. (1995) expect that the notion of sustainability will remain fuzzy, elusive, contestable, and/or ideologically controversial. Øivind (2001) dwells on this imprecision and suggests that we view the complex strategic process toward sustainability based on indicators to evaluate this intended process along three dimensions: an economic, an environmental (or ecological) and a social dimension. There is increasing support for such multidimensional views of sustainability. One such view is put forward by Reinhardt (1999) who, adopting a firm-level perspective, believes that measures of sustainability must consider not only the costs for capital, labor, and traded goods but also social costs. However, he accords highest priority to linking sustainability to productivity, investment, and profit. Elkington (1997) has also formalized the notion of a triple bottom-line. Such a model presumes that sustainability requires firms to consider not only the financial bottom-line, but as well its social and ecological "profit and loss accounts". We will employ this expanded notion of sustainability as we develop our arguments.

As the focus on sustainability has intensified, the number of strategies and concepts used by organizations to implement sustainability practices has also multiplied. Successful development of sustainable activities has emerged to be a determinant of success in the contemporary organizational environment. The sustainability discourse has largely been dominated by the

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1 In this paper we refer to ecology in terms of the notion of information ecology (Davenport, 1999; Nardi and O'Day, 1999; Capurro, 1989)
need to meet the triple bottom-line of achieving economic, environmental and social goals simultaneously. One of the objectives in this paper is to redefine that dominant notion of sustainability to meaningfully apply it to IS. Environment is one such dimension that needs to be reframed when sustainability is discussed in the context of IS.

This paper considers the organizational environment to the ecosystem where sustainable products can be made, sustainable services can be offered and sustainable practices can be deployed. Given that the notion of sustainability is important for IS researchers and practitioners, and given that the prevailing understanding of sustainability, can not be applied directly to IS, the objectives of this paper are (a) to develop trace the background for the sustainability discourse in IS research (b) provide a framework that will allow the meaningful treatment of sustainability from an IS standpoint and (c) show how practice and theory interact when the notion of sustainability is pursued IS.

This paper consists of five sections. The background section addresses the first objective by providing a historical basis for recognizing that sustainability has been an important concern for IS researchers for quite some time. This section also traces the changes in how the focus has shifted and sharpened when sustainability has been applied to an IS setting. The third section on concept development provides an overview of the problems where the concept of sustainability can provide a resolution framework in IS research. The fourth section that focuses on process as the primary conceptual construct, directs focus to the relevance of the process view for sustainability practice and research. Section five, provides an example of how organizations can incorporate sustainability dynamics. We conclude by identifying the challenges to the IS field that lend themselves to sustainability dynamics.

BACKGROUND

Our first objective was to develop a background to understand sustainability from an IS standpoint. To do that we draw up three strands of research in IS – the stage theory, IT as a source of competitive advantage and the literature on outsourcing.

The earliest stream of research that can be considered useful for the discussion of sustainability is the one initiated by Nolan’s work on stages of IS development in organizations (Gibson and Nolan, 1974; Nolan, 1973, 1979). The essence of the stage theory is that there are different stages of growth in a company's information systems function. One of the salient features of these stage models is that the IS budget increases monotonically across all the stages. As a result, the stage(s) in the middle is (are) named as the control stage. Typically in this stage, there is transition to management of data resources, which involves a restructuring of the DP organization and installation of new management techniques. Essentially, from a sustainability standpoint, the increasing rate of investment in IS cannot be sustained indefinitely and hence, management needs a framework to look for creative and innovative ways to leverage fewer or existing resources. Lucas and Sutton (1977) studied the stage model but failed to validate the S-shaped model proposed by Nolan. From a budget growth standpoint, however, they validated the monotonic increase in budgets – which is not a sustainable proposition.

The search for sustainable benefits from investments in IS also goes back to the early years of large-scale IS introduction where Millar and Porter (1985) discuss barriers to exist and barriers to entry. The essential argument in their thesis was that as long as investments in IT prevented other organizations from replicating an organization’s systems and as along as customers were attracted by the added value of those information systems, the value proposition from IS remained sustainable. However, sustained viability is threatened as soon as competitors replicate the information systems and / or customers stop differentiating between the organization and competitors based on information systems. Along the same research line, Kettinger et al. (1994) posited that information systems that can not sustain competitive impact have only transient strategic value or may offer negative value if matched by a superior response by a competitor. Mata et al. (1995) concluded that managerial IT skill set is the main attribute that can provide sustainability (the other attributes that were studies included capital requirements, proprietary technology and technical IT skills).

Over the years, as IT became more common in organizations and in the 1990s became a pervasive phenomenon, it started to become clear that information technology is necessary, but not sufficient to experience increases in productivity. The big gains come typically through complementary activities like the reorganization of work. The debate has changed from whether or not to invest strategically in IT to how to leverage the strategic, tactical and operational investments in IT for sustained advantages at the individual, group enterprise and inter-organizational level. A related development has been that IT in larger organizations (as also in mid-sized organizations) has assumed the role of a utility.

End users and consumers are increasingly expecting access to the entire converging information technology and telecommunications infrastructure in the form of a service, without having to make potentially risky investments in constantly changing and evolving information technologies. This requirement does not imply that user organizations should be the ones investing in IT. This emerging proposition also follows from the core competency argument. While IT has become increasingly ubiquitous in organizations, the presence of management of such IT is starting to move out of
organizations—typically in an outsourced mode. The IT outsourcing trend that started in the early 1990s was based on the premise that outsourcing offered a way out of monotonically increasing IT operating costs. It offered a way for end-user organizations to outsource IT (that they considered a non-core function) to and organization that contracted to meet pre-specified service levels and helped the end-user organization convert variable costs into fixed costs. However, while outsourcing can lead to a reduction in IT costs, such reduction may come at the price of reduced service (Hirschheim and Lacity, 2000). Some organizations have insourced back and have been able to experience cost reductions and efficiencies that outsourcing promises (Overby, 2003).

The essence of these three research streams has been that it is very difficult to keep control of the costs associated with IT. However, IT is critical to not only strategic, and hence competitive advantage, it is now and essential and an assumed service in organizations. While many organization shave outsourced the IS function to received a predefined service level at a constant cost, many organizations have had problems in such an outsourced arrangement too. In other words, it has been difficult to sustain the rate at which IT budgets have increased and also the level of service that is desired from IT services.

The next section will explore the nature problems in IS that can be conceptualized using the sustainability lens.

**CONCEPT DEVELOPMENT**

The relevance of sustainability applies primarily to the benefits associated with IT. We define sustainable IT investments as those whose benefits keep continuing into the future. Challenges to the value added from IT investments manifest themselves in many ways. Some information systems fail. Some information systems do not provide the level of benefits that they were supposed to, while other information systems may add value in the short run but may be neutralized by future competitive responses or even internal organizations changes. Generic challenges to sustainability have been documented as the process paradox and improvement paradox. According to the process paradox (Keen, 1997) organizations (at the enterprise level) experience a measurable decline while making significant improvements to their individual or functional processes. The improvement paradox (Repenning and Sterman, 2001) documents how gains made by organizations as a result of investments in improvement activities fall off as time goes by.

![Figure 1. Process paradox](image)

ERPs are a good example of the process paradox. Davenport (1996) discusses how the introduction of ERPs along with “best practices” can lead some organizations to fail. On the one hand an ERP system can add tremendous value and on the other hand it can run an organization aground. Successful cases show how a company can develop competitive advantages around IT systems, but an ERP developed around a function that has been diminished by an ERP implementation can lead to failure. An enterprise system by its very nature, imposes its own logic on an organization’s strategy and culture. It could rush a company toward full integration even when a certain degree of decoupling may be desirable. It could push the organization toward generic processes (often based on canned best practices) even when customized and proprietary processes may offer more competitive advantages.

Davenport (2000) also reports that ERPs are not the right choice for every organization. If a company rushes to install an enterprise system without first having a clear understanding of the business implications, the dream of integration can quickly turn into a nightmare. The logic of the system may conflict with the logic of the business, in this case, the implementation will fail, wasting enormous sums of money and resources, and weakening important sources of advantages. Akkermans and van Helden (2002) provide additional understanding of why some organizations fail and why some prosper when using ERP.
In fact the same organization may find simultaneous and mutually reinforcing changes in presence and attitudes of multiple stakeholders to enable the transition from a vicious into a virtuous cycles of ERP project performance.

The improvement paradox is defined as one where an organization or an entity is not able to sustain its performance once it reaches a certain high and desirable level of performance. According to Repenning and Sterman (2001) “today’s managers face a paradox. On the one hand, the number of tools and techniques available to improve performance is growing rapidly. Further, with advances in information technology and the ever-growing legions of management consultants, it is easier than ever to learn about these techniques and to learn who else is using them. On the other hand, there has been little improvement in the ability of organizations to incorporate these innovations in their everyday activities. The ability to identify and learn about new improvement methods no longer presents a significant barrier to most managers (p. 65).”

PRIMACY OF THE PROCESS VIEW

The need to incorporate the notion of sustainability implies the explicit incorporation of time as an analytic variable. This is important to incorporate the dynamic and temporal view in information systems (IS) research. Of late there has been an increased emphasis to move beyond variance approaches and adopt a longitudinal perspective to analyze IS or IS-related phenomena (like IS-enabled productivity, the link between use and productivity, the impact of IS on culture and vice-versa, etc.). In order to incorporate the temporal dimension, it is important to adopt a process view of organizational activity as opposed to the variance framework to explain how things work.

This is important because even after Brynjolfsson and Hitt (1998) published their resolution to the productivity paradox, subsequent studies have shown that questions regarding the impact of information systems on organizational and individual productivity still remain open. While some organizations have reaped benefits from IT investments, others have not been able to do so under similar business conditions. There are many direct and indirect influencers and determinants of how investments in IT are converted into performance or productivity effects.

Mixed results point to the multiple influences of other academic streams and the need for information systems researchers to deal with variables at different levels of abstraction (e.g. individual, group and organizational) simultaneously. Dealing with multiple levels is, first, a measurement challenge and, more importantly, a theoretical and methodological challenge. This is because multiple influences in a research model often lead to reflexive relationships (A influences B and B, in turn, influences A). Multiple influences also diffuse the effect of IT variables on individual, group and organizational performance (A influences B which, in turn, influences C and so on). Another problem with quantitative (statistical) models employed in IS research is that path weights, that capture the essence of bivariate relationships, cannot be translated gracefully into actionable items. For instance, in the heavily used technology acceptance model (TAM) (Davis et al., 1989, Venkatesh and Davis, 2000), a path weight of 0.45 between perceived usefulness and behavioral intention to use a system assumes a linear relationship between the two variables (when it is not). If the idea is to increase perceived usefulness, then the question “how do we increase perceived usefulness?” still remains unanswered. Consequently, there is a need to seek formulations of IS problems that respond well to the “how” aspect of research and practice. Lucas (1999) revisits the issues of quantifiable and non-quantifiable IT-enabled value for organizations and focuses on weakness of measurement frameworks that fail to capture IT-enabled benefits. Willcocks and Lester (1999) start with the premise that many IT investments still do not show pay-offs. They base their solution to that problem by suggesting improved measurement frameworks. The focus on improved measurement frameworks is an indication that we may not have accounted for all aspects that influence IT-enabled benefits.

payoffs or value. From a research standpoint, the use of statistical modeling to capture the benefits of IS at various levels (and to analyze other areas in IS) is by far the most preferred one. It is preferred over qualitative, interpretive methods or, as more recently suggested, process-oriented approaches (Mohr, 1982; Markus and Robey, 1988; Soh and Markus, 1995; and Crowston, 2000).

A useful view of a process is a transformation of an input (or a set of inputs) into an output (or a set of outputs). This systemic view of a process allows us to focus on the outcomes of processes (be they IT investment, IS management, IS use, decision support, IS enabled personal productivity, etc.). IS processes (and IS use processes in particular) fall under the category that Ackoff (1971) calls purposive systems. Importantly, a process view allows us to frame our analysis in terms of it does not matter what you have, what matters is what you do with what you have. This view is brought out well by Marchand et al. (2000) who show how one of two banks (comparable in most respects), was able to leverage its IT investments significantly better than the other. One of the critical differentiators between high performing and other organizations is the set of processes that these organizations have and the maturity of these processes.

OPERATIONALIZING THE CONCEPT

A useful way of operationalizing the process construct is to employ the systems perspective. Systems views are often misunderstood as being highly abstract and removed from reality. However, when the process view is adopted for analysis, the systems framework is not only congruent to the thought process, but also directly helps to addresses the sustainability problem that we outlined earlier.

Figure 3. Sustaining collapsing loops or reigning in runaway loops

To meaningfully analyze the issue of sustainability, we conceptualize a process as a set of interconnected tasks, activities or work concepts. A process is not a static concept, in that it recurs through time. From that standpoint a process can then be evaluated in terms of cycle times and variability. We draw processes as flow or causal influence diagrams. Causal influence diagrams are shown in Figures 3a and 3b.

Figure 4. Behavior of out-of-control loops

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3 A purposive system is a multi-goal seeking system – the goals of which have a common property. Production of that common property is the system’s purpose. IS use is a purposive system because “deriving additional value” is the common property of the various information systems that are used by the user.

4 Typical variability measures include process capability ratio ($C_p$) and process capability index ($C_{pk}$).
We can start reading a causal influence diagram at any point. Where we start is not important. What is important though is the identification of cycles or loops. Loops can be characterized as positive feedback or negative feedback. Positive feedback loops are called reinforcing loops. Negative feedback does not imply undesirable. On the other hand, negative feedback loops regulate or control behaviors that tend to get out of control (e.g. cost escalation, manpower attrition, runaway projects etc.). In the same way, positive feedback loops can manifest themselves as either virtuous or vicious cycles. Take the loop shown in Figure 3 (a). It can be a virtuous or vicious cycle depending on the state of variables. Starting anywhere, we could read the loop as follows: As A increases (or decreases), B increases (or decreases); As B increases (or decreases), C increases (or decreases); As C increases (or decreases), D increases (or decreases); As D increases (or decreases), A increases (or decreases). Over time, the behavior of any one of the variables shown in Figure 3(a) can be either of the ones shown in Figure 4(a) or 4(b).

It is clear that the reinforcing loop either manifests itself as a runaway growth or and uncontrollable downward spiral – both of which are unsustainable propositions. The presence of a regulating loop as shown in Figure 3 (b), by the presence of element E (As C increases, E decreases or vice versa), leads to steady-state behavior as shown in Figure 5. Regulating loops are also called balancing loops.

![Figure 5. Behavior of in-control loops](image)

The idea, then, is to sustain the steady-state behavior over time and seek to continuously seek out opportunities and practices that help prevent nosedives and unsustainable and unnatural growth spikes.

It is clear that over time, sustainability (with respect to any variable) can be conceptualized as Figure 5(a) or 5(b). In the case of IS-enabled value, Figure 5(a) depicts the desirable reference mode (behavior over time). Why would profit go downhill as shown in Figure 1 or why would the number of transactions handled first improve and then show a drop in performance? The desirable behavior for these variables is to go up and remain there. “Remaining there” has to do with sustainability.

The resolution to the dynamic behavior of a variable or a construct that is influenced by many variables and influences many variables in turn, is determined by the nature of the loops (see Figure 3) that are formed as a result of such interactions. The presence of multiple loops (which can be seen to represent many processes) leads to dynamic or changing behavior over time for the variables involved.

Figure 6 shows how IS value can be sustained over time. Investment in capability is used to refer to how time and money can be used to improve the ability of the end-user of IT. Capability erosion could take place as a result of a user not using a system for long or as a result of drastic or frequent changes to a system or workflow process. Time spent working refers to the time spent on using the information system. Pressure to do work has to do with the pressure to use the IS to accomplish tasks. Performance gap is the difference between actual and desirable performance levels. Pressure to improve capability comes from the need to become a better user of IT. Time spent on improvement refers to the time a user spends on improving computing habits, learning new “tricks” or in formal training. There are also delays between when an end-user’s capability improves and when the effect on work performance is felt. In much the same way, as time spent on improving increases, the commensurate effects of the rate at which a user’s capability improves is affected following a delay.

Figure 6 contains four loops. Three of the loops are balancing loops while the fourth loop is the reinforcing loop. The working harder and working smarter loops can be thought of in terms of what Soh and Markus (1995) transforming IT assets into IT-enabled value. It is clear that time spent on improvement is clearly in conflict with time spent using the IS and pressure to use the IS. This means that the more a user uses a system, the less time a user invests in learning how to use the system more effectively. If instead a user learned to leverage the IT asset more effectively (something akin to second-order learning), the investments in the IT asset can be leveraged better and for a longer period.
The key to ensuring that an information system delivers sustainable benefits lies in the understanding how effort and resources are expended and distributed in the short and long term. Short-cuts and short-term fixes, while they work well for a limited period, add less value with time. The major implication from this analysis lies in the need to continuously look for improvement opportunities and analyze how those opportunities can be translated into increased value. Given that large-scale investments in IT are not a recurring feature and given that course correction based on righting a wrong technology choice is not a viable option, improvements need to be based on processes having to do with IT operations, management of IT, IT use and work-processes integrated with IT.

One of the roadblocks to experiencing such improvements is the absence of well-accepted and valid measures for performance levels. Specific measures are difficult to develop because every organization uses IT differently. However, generic measures based on broad classifications like customer (internal or external) satisfaction, IT operations (response time for problem resolution, support staff per user), system performance (downtime per day/week, complaints per user) and the end-user (dollars per user for training, end-user maturity ratings).

At the individual level these include inefficient workarounds or not using a certain functionality because either a user does not know the existence of that function or because a user does not know how that functionality plays out. At the enterprise level, short–term fixes or short-cuts include cutting back on training or not upgrading or patching systems with fixes.
Once a measurement framework is in place, and a continuous monitoring system has been deployed, a large portion of the improvement effort can be handled by end-users or groups of users. Once the process view is in place, the use of techniques like six-sigma improvement can be deployed so that improvement projects are always in place. The presence of improvement projects in the domain of IT is important because it forces IT to be seen in the light of other functional areas and cross-organizational linkages. Once, users recognize these linkages and the role of these linkages in fostering or inhibiting the IT-enabled performance measures, they will be able to work toward the IS value graphs shown on the right in Figure 7.

In order to work toward sustainable benefits, the rigidity and stringency of the desired performance is key. In order to close the performance gap, the options available to an organization include enhancing actual performance or diluting the level of desired performance. While diluting the level of desired performance will reduce short-term pressures, it will also reduce the motivation to improve IT management and use processes. The long-term consequences will obviously be to reduce overall IT capability. Therefore, the desirable strategy is to keep performance goals fixed and suffer short-term performance penalties, while working toward improved processes for management and use of IT. This requires flexible attitudes and processes. While flexibility is desirable, this can only be leveraged if the requisite discipline exists in IT operations. The role of discipline is crucial to ensure that performance levels do not drop below a certain level, even while working to improve existing processes. A drop in existing performance levels may adversely influence the reinforcement loop and change it from a virtuous to a vicious cycle.

CONCLUSION

It is clear that IT benefits can not be sustained for a long time because users change, systems change, technology changes and organizations change. While good technology is indeed a determinant of IS value, technologies cannot be changed frequently. Once a technology has been chosen (hopefully a good technology) and implemented with promise of adding value, the next stage is crucial in that users and the IS have to collectively co-create the value that is expected of the IT.

REFERENCES


