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THE ROLE OF STRATEGY IN THE EVOLUTION AND INNOVATION OF INFORMATION SYSTEMS: A SIMULATION EXPERIMENT

Kevin P. Gallagher
Northern Kentucky University, kevin.gallagher@nku.edu

Bryan Hosack
Illinois State University, bhosack@ilstu.edu

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Kevin P. Gallagher, Business Informatics Department, College of Informatics, Northern Kentucky University, Nunn Dr. 233, Highland Heights, Kentucky, 45226, kevin.gallagher@nku.edu

Bryan Hosack, School of Information Technology, Illinois State University, Campus Box 5150, Normal, Illinois, 61790-5150, bhosack@ilstu.edu

Abstract

Information Systems (IS) have come to play a larger role in how organizations function, including consideration in strategic planning. Responding to competitive change or enacting a new strategy often requires modifying or enhancing an organization's IS. In this paper, the authors develop a process model of evolutionary change to address the role that IS plays in organizational strategy. The model is based in part on Miles' strategic typology of Defenders, Prospectors and Analyzers. The model examines how strategic approaches influence attention to environmental change, investments in IS capabilities, and evolution of information systems.

The behavior observed in the simulations corresponds with the theoretical hypothesis developed from the model. The conservative defender organization experienced few discontinuous changes in the simulated 20 years. The innovative prospector organization exhibited extensive change, while the balanced approach of the analyzer organization fell between the two extremes. This study has taken steps to create simulations that approximate the behaviors predicted by a theoretical process model. The success of the simulation modeling in this study builds a foundation for future research.

Keywords: Strategy, IS Strategy, Organizational Change, Simulation.

1. INTRODUCTION

Responding to changes in the competitive environment, be it to take advantage of new opportunities or to respond to competitive threats, remains an important concern for organizations and the management of their information systems (IS). Such environmental changes may necessitate modifications or enhancements to an organization's IS in order to facilitate changes to products, services and the work processes that support them. Possessing or lacking the IS capacity and capabilities to undertake such changes may hold important implications for an organization's performance.

The occurrences of change in the environment are not completely independent events. To an organization, change events may will hold greater or lesser relevance depending on the importance that the events and adaptability hold for an organization's strategy. Understanding the implications of different strategies, the occurrence of environmental change and how those events effect the evolution of systems can provide important contributions to theory and practice. Yet, little research has explored the connections and interrelations of organizational strategy, environmental volatility and the evolution of IS.

This research explores these relationships by examining how opportunities and demands for change in organizations affect the evolution of information systems. Our approach is to model patterns of environmental change and the evolution of IS capabilities in organizations by conducting controlled experiments with a computer simulation, an approach identified as one that can aid in the study of IS strategy (Sabherwal et al. 2001). We believe this theoretical model and simulation establishes a foundation for continued research in this area.

2. THEORETICAL FOUNDATIONS AND RESEARCH MODEL

A fundamental concern in strategic management is the relationship an organization has with its environment. In approaching the evolution of an organization and the interaction between strategy, environment and information systems, we subscribe to the strategic choice perspective as outlined by Miles, et al (1978). As stated, "organizational behavior is only partially preordained by environmental conditions". Management determines target customers and markets, in conjunction with investments in technical and administrative functions (Miles, et al. 1978).

Management also makes choices about investments in resources. From a resource-based view, Grant conceptualizes strategy as "`the match an organization makes between its internal sources and skills…and the opportunities and risks created by its external environment'" (Grant 1991, p. 114). Investments in capabilities play a role in how organizations perceive their ability to respond to opportunities and demands. As a result, there is an interrelationship between the occurrence of environmental change, and the evolving design of products and services and the perceived need to undertake incremental or discontinuous changes in an IS.

2.1 Strategic Choice and Adaptation

Undertaking an evolutionary perspective, we are interested in what Miles, et al called the "adaptive cycle". In this cycle, organizations seek to solve several interrelated problems; entrepreneurial, engineering and administrative. Entrepreneurial activity is realized through the enactment of an organization's market position and product and service designs (Venkatraman 1994). The engineering problem is realized in their enactment of technology, such as information systems. The administrative problem has two conflicting issues; how to create structures and processes that enable the current strategy, while also enabling future innovation. We approach the administrative choices as realized investments in the ability to deliver both current and future capabilities.

The challenge for organizations is in "not allowing the systems to become so ingrained that future innovation activities are jeopardized" (Miles, et al. 1978). We view IS as a key strategic resource for organizations trying to enact changes in product, service and market approach. However, the structures and processes of an IS designed to serve today's environment can enable, but sometimes constrain future capacity and capabilities for future innovation. Miles et al. asked how do organization's move through this adaptive cycle? We ask how do information systems evolve as these adaptive cycles unfold?

Miles et al. (1978) proposed a typology of three strategic types that characterize organizational approaches to dealing with environmental change, uncertainty and adaptation—defender, prospector, and analyzer. Defenders are concerned with maintaining stability and efficiency in the design of their products and services, systems, processes and technologies that support them. On the other end of the continuum is the prospector strategy, in which flexibility and change are the driving forces. Prospectors explore new markets, product and services continually, much the same as the innovating firms explored in the work of Nelson and Winter (1982). This typology was applied to IS strategy by Sabherwal and Chan (2001), as well as others who have built on their research.

Lying between these two are analyzers, who try to undertake the difficult balance of maintaining flexibility while being efficient. Analyzers behave in similar ways as imitating firms conceptualized in the work of Nelson and Winter (1982). Analyzers wish to reap the benefits of both Defenders and Prospectors by remaining adaptable and controlling costs. A fourth possibility is the Reactor. The reactor is characterized by Miles et al. as a non-strategy and will therefore not be included in this study (see also, Sabherwal and Chan 2001).

These three approaches to strategy influence how organizations respond to environmental change. For this paper, we define environmental change events by their frequency, amplitude and instability, as defined by Wholey and Brittain (1989). We draw on work by Child (1972) and Hannan and Freeman (1977) to develop these constructs. Frequency is of course the number of environmental changes identified over a set period of time. Amplitude is the magnitude or size of changes experienced by organizations. Instability is the randomness resulting from uncertainty and inability to predict future environmental events.

2.2 Information Systems and Strategic Adaptation

Advances in information technology increasingly offer organizations the opportunity to adopt or create new innovative products, work processes and market strategies (Sambamurthy and Zmud 2000). An evolving information system allows organizations to extend their processing capacity and the capabilities to support business processes. By extending and enhancing their existing information system, organizations can expand the system's range and reach (Keen 1991), while also developing new capabilities (Copeland and McKenney 1988).

Effectively leveraging information technologies can enable organizations to sense and respond to opportunities and demands in their competitive environments (Sambamurthy, et al. 2003). These IS capabilities are formulated in both technologies and human resources and provide the ability to employ resources in ways that enable delivery of new products and services (Bharadwaj 2000).

This approach to strategy is supported by the resource-based view of the firm (Penrose 1959, Grant 1991, and Bharadwaj 2000). Bharadwaj (2000) discusses the role of IT infrastructure and IT human resources. In this paper, capacity is defined as the resources, technology and man-power that allow organizations to cope with change. Bharadwaj (2000) also discusses the intangible IT resources that a firm holds, which are collectively grouped as capabilities in this study. These assets can include processes, routines, and regular and predictable behavior patterns of a firm (Nelson and Winter 1982). These assets are improved over time through organizational learning and experience (Cohen and Levinthal 1990).

At the heart of Miles'et al. work is the importance of innovation. Innovations are viewed in this study as realized changes to the design of products or services that take advantage of opportunities or respond to competitive demands in the organization's environment. IS can enhance an organization's ability to respond to these demands, adapting its product and service offerings by, for example, altering their product scope and market reach.

The scope of the organization's product is defined for this study as the number of components in the product. If the components are closely interrelated, then any change in the design of one component will require corresponding design changes to others. This association increases the rate of change in a system, as adoption of one innovation creates ripple effects throughout the overall IS design. Reach is the number of markets in which a firm competes. Reach is determined, for example, by geographic or channel expansion. Extending reach, an organization encounters a greater number and variation in competitors, regulations, and customer needs.

The dynamics of the adaptive cycle and turbulence in the environment increases with the growth of scope and reach. So relevant changes are expected to occur more frequently, especially those having a greater amplitude and instability when moving along the continuum from defender to prospector. As the number of changes increases, it raises the demands placed on an organization's IS department. Thus, the organization's choices when solving "engineering" and "administrative" problems hold implications for its ability to adapt an IS in a way that enables it to realize its chosen strategy.

2.3 Operationalizing Change in Information Systems

In the management of IS, maintaining or developing flexibility relies on the development of certain technical and organizational capabilities. Capacity is supported in information system design through the concept of scalability, which allows for growth in the number of users and the volume of data processed, but also to expand the type and volume of data collected and stored. For human resources, capacity is concerned with the presence of slack resources, which facilitate the ability to undertake change and provides adequate time for planning, monitoring and learning from experience. Adequate levels of staffing in the organization influence the ability to support the adoption of innovations.

Important to the development of capabilities is organizational learning. Learning is realized and accumulated over time and influences the organization's tendencies toward remaining innovative and maintaining its ability to implement change (Copeland and McKeeney 1988). Capabilities for change are enhanced as the organization experiences events, especially those offering greater development of experiences and knowledge (Cohen and Leventhal 1990).

Alternatively, inertia constrains an organization's capacity and capabilities for change. Inertia builds through a series of design decisions (Gersick 1991), escalating commitment to decisions over time (Huff and Huff 2000), and exploiting current knowledge and capabilities (March 1990). Depending on various factors regarding an information system, such as its age (Swanson 1994) and design (Broadbent, et al., 1999), technology may enable or constrain the implementation of change in information systems.

The inability of an organization to respond to desirable opportunities or competitive threats in the environment due to inertial constraints will increase stress in the organization. Stress is realized in the desire for new approaches to resolving existing problems (Huff and Huff 1991). This often translates into a radical break from existing structures and practices (Tushman and Romanelli 1985).

Inertia and stress are not mirror images of the same concept, but complimentary (Huff and Huff 1991). As inertia rises in a system, stress also rises, but the rate at which stress increases is also dictated by the demands placed on the capacity and capabilities of IT to implement change. If stress exceeds the organization's threshold of acceptability, then the organization will begin to look beyond existing solutions and begin searching for alternatives (Tushman and Romanelli 1985). Until the tolerance for stress is surpassed, then the cumulative effects of inertia will continue to constrain the organization's ability to implement change, potentially stifling innovation (Huff and Huff 2000).

Outcomes that result from the tension between inertia and stress are patterns of incremental and radical change that punctuate long periods of equilibrium with short periods of radical change (Huff and Huff 2000). Such patterns are consistent across theories of scientific advancement, organizational change and information systems (Kuhn 1996, Tushman and Romanelli 1985, Gersick 1991, Orlikowski 1993). Changes in this study are classified as small adaptations that amount to the continuation of the status quo; enhancements to the system that extend its reach and range and discontinuities that reengineer or replace significant parts of the system.

2.4 An Evolutionary Process Theory of IT Innovation

Simulations were constructed based on the research model proposed below in Figure 1. The model includes relationships found in the literature review above. The behavior of the model also simulates the findings of historical case studies conducted in the U.S. property and casualty insurance industry (Gallagher 2008, Gallagher and Worrell 2008, Gallagher 2002). The studies documented the occurrence of discontinuous changes in these organizations over a thirty years period. The organization's strategy and attention to changes in the competitive environment resulted in varying occurrences of discontinuous change events, i.e. the reengineering or replacement of IS.

The model is based on the theoretical relationships among organizational strategies (defender, analyzer, prospector), their implications for managing the competitive environment (product scope, market reach), and occurrence and characteristics of change events (frequency, amplitude, instability). The ability to implement change is dependent on an organization's IS capacity and capabilities. When the ability to respond to change is constrained by increasing levels of inertia, the organization's stress will rise. Ultimately, the inability to respond to the environment leads to occurrences of discontinuous change.

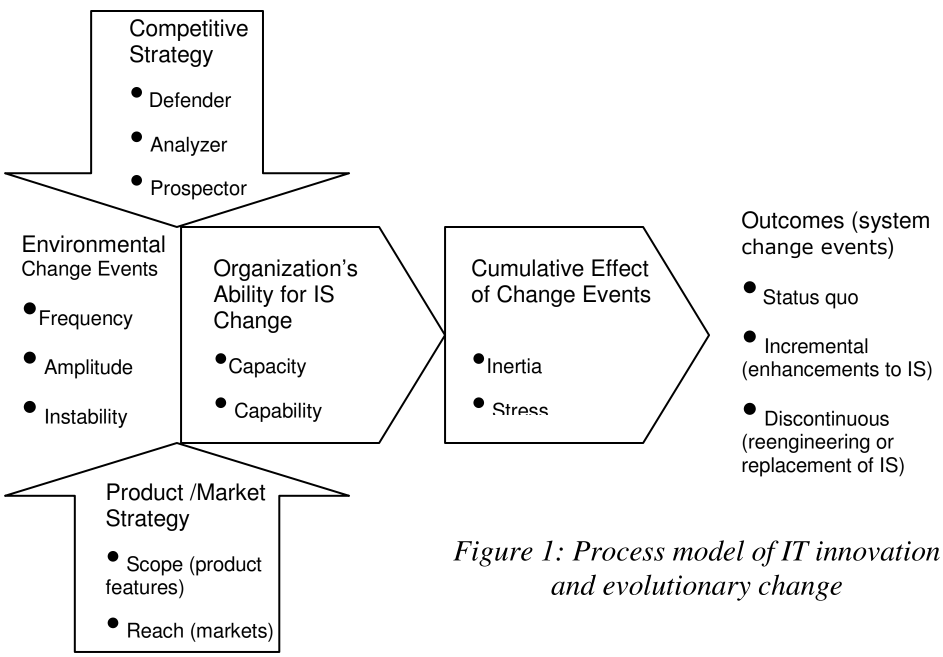

Figure 1: Process model of IT innovation and evolutionary change

In the research model, changes in the environment are encountered as opportunities and demands for change that ultimately result in the evolution of the system. The outcomes of these events are either a continuation of the status quo (no change adopted) or the enactment of change events. The events are adopted as either incremental or discontinuous changes, based on the events and the current state of the system. The incremental or discontinuous nature of the change affects the evolutionary patterns of change in a system.

The organization's strategy (using Miles, et al. 1978 Defender, Analyzer, or Prospector) acts as the directional forces in the model that influence the trajectory of events. Of specific importance are the strategy's influence on scope and reach of the organization's products and services and the resulting demands for change in an IS.

3. GENERAL SIMULATION MODEL

The simulation experiments conducted in this study were discrete and event-based. Four simulation experiments were conducted. Each simulation model in the experiment ran for 20 years (after an initialization period of two years). Arena simulation software was used to create the models. Since the models presented here are intended as a baseline for future studies, other simulation approaches maybe consider as model complexity increases.

As the simulated organizations encounter opportunities and demands for change in the competitive environment, characterized by their frequency, amplitude, and instability, the model describes how these variables influence the evolution of an IS and ultimately an organizations ability to implement change. The ability to change is enabled by having both sufficient capacity and capabilities. Over time, as existing processes are stabilized through status quo changes (i.e., changes within the capacity and capabilities of the organization) and adopted incremental changes (i.e., changes within either the capacity or capabilities of the organization, but not both). Thus, each event has the ability to increase the level of inertia in an IS due to the passage of time, increased size and complexity. The challenge is to then alleviate the stress that builds as the ability respond to environmental changes decreases. For example, lacking adequate capacity for adopting an incremental change, a major enhancement to the system may be necessary, requiring a discontinuous change.

The first variable associated with a change is frequency, which represents the stability or turbulence of the competitive, regulatory and/or technical environment in which the organization competes. Frequency is influenced by strategy and determines the number of changes that ultimately enter the simulation. As changes enter the simulation, they are assigned, amplitude and instability values. Based on these values, a change will be considered as a potential enhancement for the IS. If a change enters the system, it is then evaluated, based on the amplitude, which represents the time, effort and talent required to implement a change into the existing systems. Amplitude is compared with organizational capability to handle the change. The other variable that is considered is the instability of a change, representing the difference from the existing information system's technology, the capabilities of the IT personnel and the design of the products and services it supports. The consideration of these variables is to determine if there is enough capacity and capability to handle the change. For each simulation, inertia acts as a multiplier of amplitude and instability when comparing these values with capability and capacity, respectively. When the current capacity and the capability are sufficient, the change is made and inertia increases based on a portion of the amplitude associated with the change. In this situation, only half of the amplitude is added to the current level of inertia for status quo changes.

When technical capacity are inadequate at the time a change is encountered, but there is enough knowledge capability to handle the change, an incremental change occurs increasing inertia at the full amplitude associated with that change. The logic behind this process is indicative of a situation where excess capacity is not available, yet the acquisition of additional resources can supplement the adoption of the intended change. Capacity and capability are both fixed at 0.75 for the purpose of our simulations. Future studies will examine varying capacity and capabilities. The function for the increase of inertia with regard to capacity and capability is shown in Equation 1.

$$F(I) = \begin{cases} I + \frac{A}{2}, if\ I * A \leq Cp\ and\ I * Is \leq Cb \\ I + A, if\ I * A > Cp\ and\ I * Is \leq Cb \\ 0,\ otherwise \end{cases}$$

I = Inertia	Is = Instability
S = Stress	Cp = Capacity
A = Amplitude	Cb = Capability

Equation 1: The Growth of Inertia

The implementation of status quo and incremental changes will increase the levels of inertia in a system as enhancements to the design increases the size and complexity of the system. The inability to respond to changes as a result of constraints on knowledge capabilities or a combination of inadequate capacity and capabilities creates stress in the organization. Stress is realized in the desire for new and innovative approaches to the resolution of problems and cumulatively contributes to the organization's consideration of radical change. In this case, radical changes translate into the redesign or replacement of some or all of the existing system. Once a new system is implemented and the organization's capacity for change and the capabilities to adopt future changes are available, stress is reduced. As inertia builds in the simulation due to status quo and incremental changes, stress begins to build with each change that is not within the capabilities of the organization at a rate of half the amplitude associated with a change. If both capacity and capability are inadequate to deal with a change, stress increases by the full amplitude associated with the change.When discontinuities occur the stress variable is reset. Stress increases under these conditions, as shown in Equation 2:

$$G(S) = \begin{cases} S + \frac{A}{2},\ if\ I * A \leq Cp\ and\ I * Is > Cb \\ S + A,\ if\ I * A > Cp\ and\ I * Is > Cb \\ 0,\ otherwise \end{cases}$$

Equation 2: The Growth of Stress

Each simulation experiment builds on this simplified model. Three levels of complexity are added to provide a higher-level organizational realism. Each experiment is outlined below. First, the implementation of strategy in the simulation is discussed. Next scope and reach are added to the strategy models. In the third set, capacity and capability are added to the model. Finally, all variables are combined into an integrated model that includes strategy, scope, reach, capacity, and capability.

3.1 Experiment 1: Strategy and the Environmental Conditions

Strategy determines how the organization sets performance objectives and the demands placed on its systems to adopt changes over time. First, goals may focus on growth, stability or both. As a result, demand for change differs across organizations or within any one organization over time. For instance, growth may expand the geographic reach of the firm, resulting in increased opportunities and demands for innovation as more customers, competitors and regulators must be considered. This places increasing demands on the capacity and capabilities for change in the IS. Stability on the other hand, represents a focus on using IS to increase efficiency, which in turn leads to increased profitability in the short run.

Three simulations were conducted—one for each proactive strategy as outlined in the typology offered by Miles et al. (1978). The Defender approaches environmental conditions with the goal to minimize the impact of frequency so that fewer discontinuous changes occur. The Prospector, on the other hand, encounters change events of larger size having a much higher frequency, amplitude, and instability associated with change than the Defender. The Analyzers try to balance efficiency with opportunity in evolving the system, falling somewhere between Defenders and Prospectors. In the first simulation, change events occur with a probability of 25% for Defenders, 50% for Analyzers, and 75% for Prospectors.

Within the first set of experiments, the organization's IS capability and capacity for change are fixed at the same predetermined level for each strategy. Prospectors carry a lower level of inertia, due to the desire for rapid change increasing. Defenders carry the highest levels of inertia because stability is valued in the quest for efficiency. In contrast, Prospectors have a much lower threshold for stress than Defenders due to the perceived need for change. Again, Analyzers fall somewhere in between trying to integrate both the Defenders and Prospectors goals. The threshold for each strategy was set to allow for adequate variation between strategies based on pilot studies. The first experiment tests the following hypothesis:

> **H1: Prospectors will experience a greater number of discontinuities than Analyzers, which in turn will experience a greater number of discontinuities than Defenders.**

3.2 Experiment 2: Strategy, Scope and Reach

The second set of simulations introduces the effect of scope and reach associated with changes in product and service designs. Reach defines the size of the geographic market, while scope deals with the range of customers served in a market. Scope and reach will increase the frequency, magnitude and instability of the demands for change. Specifically, scope of the product will increase the frequency and magnitude of these events as it extends the number of potential customers within a population by expanding the range of possible contingencies necessary to compete across customer segments. Conversely, reach increases the frequency and instability of changes entering the system. For example, if a new set of features are added to an existing set of product dimensions, it increases the complexity of the overall design. Within the simulation, the set of environmental conditions (frequency, amplitude, and instability) increase over time as scope and reach is increased, resulting in more frequent and varied change events entering the system.

In this experiment, the Defender will focus on stability and efficiency, minimizing the scope of products offered and the reach into different markets, thus having a narrower scope to its products and more limited in changes to market reach. The Prospector on the other end of the continuum will always be scanning for new markets to enter and products to offer, so it will experience greater frequency of change events. The Analyzer balances scope and reach to achieve efficiencies, without passing up profitable opportunities. The effect of scope and reach are hypothesized as follows, based on an organizations strategy:

> **H2: Increases in scope and reach of products will result in more discontinuous enhancements to the system for all strategies when compared to Experiment 1.**

3.3 Experiment 3: Strategy, Capacity and Capability

Until now capacity and capability have been held constant across strategy. However, it is unrealistic to expect organizations not to invest in capacity or develop greater capabilities as they learn from their experiences in adopting change. Investments and system feedback, therefore, are incorporated in our model. Each strategy is assumed to improve both capacity and capability, but each strategy increases at a rate of change consistent with its intended goal. As incremental changes are adopted (versus status quo changes) capacity increases to accommodate the change. This expanded capacity can then be exploited to meet future demand for change. Defenders focus more heavily on capacity investments to increase the efficiency of the system. Prospectors, in contrast, are less concerned with capacity in favor of increasing capabilities and Analyzers strike a balance between the two ends. A feedback loop for learning occurs to reduce stress as the organization handles status quo change events increasing the organizations confidence as shown in Equation 3:

$$H(S) = \begin{cases} S - \frac{A + IS}{4}, if\ I * A \leq CP\ and\ I * IS \leq CB\ and\ S - \frac{A+IS}{4} \geq 0 \\ 0,\ otherwise \end{cases}$$

Equation 3: The Decrease of Stress from Increased Knowledge Capabilities

Learning stabilizes each strategy by increasing capacity and capabilities levels to a point where Prospectors increasingly perform as Defenders in our earlier simulation experiment, experiencing a lower number of discontinuities do to decreased levels of cumulative stress. The effect of organizational learning is hypothesized as follows, based on an the organization's strategy:

> **H3: Increases in capacities and capabilities of products will result in fewer discontinuous enhancements to the system for all strategies when compared to Experiment 1.**

3.4 Experiment 4: An Integrated Simulation Model

Finally, a set of models were tested that incorporates each of the variables discussed above. Strategy provides the foundation for the behavior of scope and reach, as well as investments in capacities and capabilities. The expected result is a balanced model where the increase in discontinuities resulting from scope and reach will be offset to a degree as investments are made to capacity and capability. The result is a decreasing number of discontinuities. The expected behavior is predicted by the following hypotheses:

> **H4: Increases in capacity and capability from learning offsets the increases in product scope and reach, causing the number of discontinuities to be equal to or less than those seen in Experiment 1.**

4. Simulation Results

Figure 2 provides an example of how the three strategies behaved in Experiment 1 accumulating inertia (black line), and stress (gray line), over a ten year period, or half of the simulated time. With each discontinuous change inertia and stress are reset. The level of inertia, as seen in the Figure, is higher for the Defender and lowest for the Prospector. For the Defender, stress builds slowly and the organization operates under stress for longer periods of time before reaching the threshold for change.

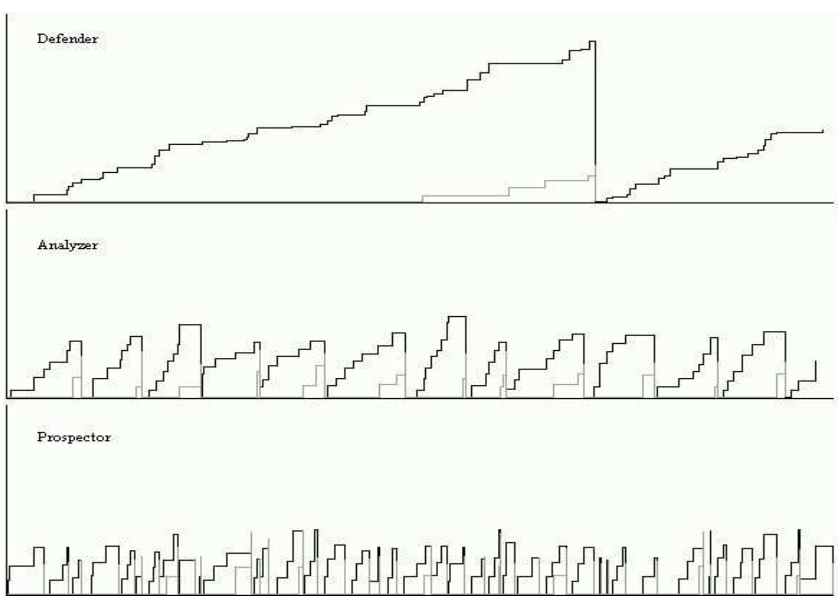

Figure 2: Sample Runs of the Three Strategies

Table 1contains the number of status quo, incremental, and discontinuities experienced for each strategy in the four experiments.

In comparing the three strategies, Defender has the fewest discontinuities and the highest level of inertia (see Figure 2). The Prospector has a much higher number of discontinuities (80) than the Defender or Analyzer and the lowest level of inertia. The findings support Hypothesis 1.

For Experiment 2, the addition of scope and reach to the first set of experimental models indicates an increase in discontinuities for all three strategies indicating support for Hypothesis 2. For example, the Defender experienced three discontinuities versus the two seen in Experiment 1.

The effect of learning exhibits a decrease in number of discontinuities over time for each strategy. Thus, Hypothesis 3 holds true for the third experiment. There is also a related trend of increasing inertia, due to higher levels of capabilities to handle change (Figure 1).

The final simulation experiment examines the full model behavior. Each model had fewer discontinuities as predicted by Hypothesis 4. Inertia in each run is higher than previous models, indicating that a slight interaction effect between scope and reach variables and the capacity and capability variables may exist.

		Status Quo Changes	Incremental Changes	Discontinuous Changes
Experiment 1	Defender	108	13	2
	Analyzer	151	13	23
	Prospector	208	15	80
Experiment 2	Defender	115	18	3
	Analyzer	203	44	22
	Prospector	222	22	127
Experiment 3	Defender	90	21	1
	Analyzer	166	15	11
	Prospector	269	13	26
Experiment 4	Defender	91	52	1
	Analyzer	240	18	17
	Prospector	326	18	27

Table 1: Change by Strategy for Each Experiment

5. DISCUSSION

The behavior observed in the simulations corresponds with the behavior observed in the historical case studies referenced above. The Defender in the final model had one discontinuous change in 20 years, which is closely approximated by the Defender strategy in our simulations. The Prospectors and Analyzers in this simulation study also mirrored the behavior of the organizations observed in that study.

The simulations themselves behaved as intended. The first set of models set the baseline by which to compare the other models. The addition of scope and reach creates more discontinuities due to the increase of magnitude and instability associated with the changes, thus all strategies behave more as Prospectors as time increases due to the increase in discontinuities. The addition of organizational learning as a stress reducer creates a set of models where strategies behave more and more like Defenders over time with fewer discontinuities. Finally, the last set of models exhibits the expected cancellation of increasing inertia and stress from the effect of scope and reach due to the ability of an organization to handle more inertia through learning. For Experiment 4, the simulation behavior is dictated primarily by strategy in the same manner as the first experiment. The findings for this set of experiments has illustrated that the behaviors predicted by the research model can be simulated. The findings provide the foundation for this ongoing research project. The findings contribute to the MIS field by providing a set of simulations that model IS strategy, an area of research that is of continuing interest to the field (Sabherwal, et al. 2001).

6. LIMITATIONS AND CONCLUSION

The experiments conducted in this research were designed to model and operationalize the process model proposed above. The study examined the role of strategy in the adoption of changes to IS within the organization in response to changes in product scope and reach in addition to increases in capacity and capability. The simulations successfully illustrated the behavior predicted by the model.

There are associated limitations with the study. The first limitation is in using simulations to approximate organizational behavior. While the simulations are complex, they do not account for all possible variables seen in the adoption of IS change. yet, limiting the number of variables in the model is necessary to make the simulation models parsimonious and testable. Secondly, sensitivity analysis is not included here. Sensitivity analysis is necessary to determine the robustness of the models with regard to extreme cases of behavior. Archival industry data can be used to set parameters and compare behavior across an industry as a step toward validating the process model. Once behavior is consistent within one industry, the model can be tested and the predictive behavior can be assessed. Finally, testing the scope of the model across industries will be an important step in examining the explanatory value of the process model.

This study has taken steps to create simulations that approximate the behaviors predicted by a process model. The next step is to integrate this research with historical data to further test the validity of the model. The final result will provide insight into how strategy, knowledge capabilities, and IT capacities can improve organizational performance. The success of this study will allow the research to proceed to the next step, the calculation of model parameters from a subset of the historical data collected via case studies. Simulation performance can then be compared with the remaining case data to validate the model. Once validated, the simulations will provide a useful tool to model changes in strategy and provide insight into when organizations should adopt a particular strategy.

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