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# Opening up the Black-Box: Information Systems and Organizational Agility

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## ABSTRACT

Successful organizations need to exhibit characteristics of agility, in order to stay ahead of their competition, and in some cases even survive in fiercely competitive environments. While the goal of any organization is to deploy its resources, using its processes, in an effective and efficient manner to meet market demands and stakeholder expectations; the agile organization must be able to deploy its resources, using its processes, in a proactive and reactive manner, under time-sensitive conditions. This agility requires a focus on continuous improvement and learning in order to increase the speed, lower the cost and effort, and improve the effectiveness of any changes. The objective of this paper is to examine how information systems can both enhance and suppress organizational agility.

## Keywords

Agility, Organizational Agility, Information Systems, IS Design, IS Management.

## INTRODUCTION

Organizations are made up of resources (assets) and processes (capabilities) (Leonard-Barton, 1992; Teece, Pisano and Shuen, 1997; Winter, 1987). The challenge for any organization is to have the right resources and processes for the market conditions of today and tomorrow (Tushman and O'Reilly III, 1996, 1997). Having the right resources for competing today is good, but not sufficient for organizational success. An organization cannot just be short-sighted in its planning efforts. Moreover, not only does an organization need to be agile in how they acquire and keep their resources up-to-date, but they must also have nimble and agile operating structures and processes. Being effective and efficient is required; however, doing so is not sufficient. An organization must be able to do these in a timely manner, with speed and vigor, especially when faced with rapid and unexpected change.

According to The Oxford English dictionary, agile means "(1) having the faculty of quick motion; nimble, active, ready (2) easily moved." Let us consider the analogy of athletes and the game of rugby. Rugby is a very fast game with quick changes in direction and unexpected moves by members of the opposite team. The key differentiating factor for rugby players who play at the highest level is that they can mobilize their physical assets, using their skills and experiences, in an agile manner that allows them to be successful. These players have excellent perception of what is happening on the playing field, can process information at a faster rate than others, and consequently can proactively play their game, rather than solely reacting to their opponent's move.

Organizations face the same challenge in today's turbulent environment. If they are going to be competitive in today's business world which is filled with uncertainty and change, then, like the rugby player, they must be prepared to anticipate their competitor's moves but also be ready to react when the unanticipated happens. At the corporate level, Goldman, Nagel and Preiss have proposed the following definition of business agility:

“For a company, to be agile is to be capable of operating profitably in a competitive environment of continually, and unpredictably, changing customer opportunities” (Goldman, Nagel and Preiss, 1995).

This ability to anticipate change, marshal resources, and react successfully to the unanticipated is how an agile organization will differentiate itself in the marketplace.

The focus of this paper will be to describe the role of information systems in organizational agility. We intend to open up the black-box of the role of IS in organizational agility, take a balanced view that includes the positive (focus of most previous research) and negative sides of the IS role thus directing some needed attention on how information systems can suppress organizational agility.

## LITERATURE REVIEW

### Agility

One of the fundamental reasons that agility is important in today’s business environment is the impact of change and the need to manage change. Managing change requires more in the toolbox than just reacting to change (which is a defensive posture). It also means anticipating change and even leading change. Truly effective companies are able to recognize opportunities and force their competitors to change. Organizations must recognize when to react, when to anticipate, and when to lead change (Brown and Eisenhardt, 1998).

Agility is one of the fundamental characteristics required to deal with change. Agility requires organizations to dynamically anticipate and react to changes in markets and structures. It is open-ended in never being satisfied with the status quo and always looking for the next step in the journey. In fact, the agility journey is one that never ends. Agility requires embracing change, not shying away from it. Beyond embracing change, agility is about aggressively creating change – creating new markets, creating new business processes, creating new organization structures (Goldman et al., 1995).

### Organizations and Agility

What does agility mean for an organization? If an organization moves in a quick and easy fashion, can we call it an agile organization? Simply because an organization moves quickly or easily does not necessarily mean that it moves in a way that is a beneficial response to changes that are impacting the organization. Four dimensions of agility have been proposed: 1) enriching the customer, 2) cooperating to enhance competitiveness (addressing how to work with partners in the supply chain), 3) organizing to master change and uncertainty and 4) leveraging the impact of people and information (Goldman et al., 1995). These dimensions are clearly related to how a company manages change and give an indication of how nimble the company is in interacting with its all aspects of its environment. The following is a description of organizational agility that was given in the context of agile manufacturing:

“Agility refers to the nimbleness of a company to quickly assemble its technology, employees, and management via a communication and information infrastructure in a deliberate, effective, and coordinated response to changing customer demands in a market environment of continuous and unanticipated change”(Amos, 1998).

This encompasses the concept of resources and the ability to manage or assemble those resources. In addition, the importance of the information infrastructure is clearly brought out in this definition.

### Information Technologies and Agility

As noted in the previous definition, communications and information infrastructure are considered key aspects of an agile organization. In agile manufacturing, technology (including information technology) provides one of the three interlinked pillars of support for agility (Kidd, 1994). The leveraging of shared information through information technology infrastructures is important to the development of agile capabilities in the supply chain (Christopher, 2000). Information technology is vital to the creation of the virtual enterprises required by agile organizations (Song and Nagi, 1997). Others have looked at how information technology needs to support the cooperation dimension of agility by supporting appropriate communication mechanisms across boundaries. Two mechanisms that have been identified as critical for successful information systems in an agile organization are “linkability” – the ability to stitch tools and networks together – and “malleability” – the ability to facilitate the change of system behavior to better meet needs (Reich, Konda, Subrahmanian, Cunningham, Dutoit, Patrick, Thomas and Westerberg, 1999).

However, challenges associated with the utilization of information technology to support agility have been noted. Legacy systems are often inflexible and unable to support the needs of an agile organization (Reddy and Reddy, 2002). Not

surprisingly, it has also been shown that information technology in and of itself is not sufficient to enable agility. It may be a necessary support tool, but some studies have shown that it is not the primary enabler of agility (Mondragon, Lyons and Kehoe, 2004).

**PROPOSED CONCEPTUALIZATION OF ORGANIZATIONAL AGILITY**

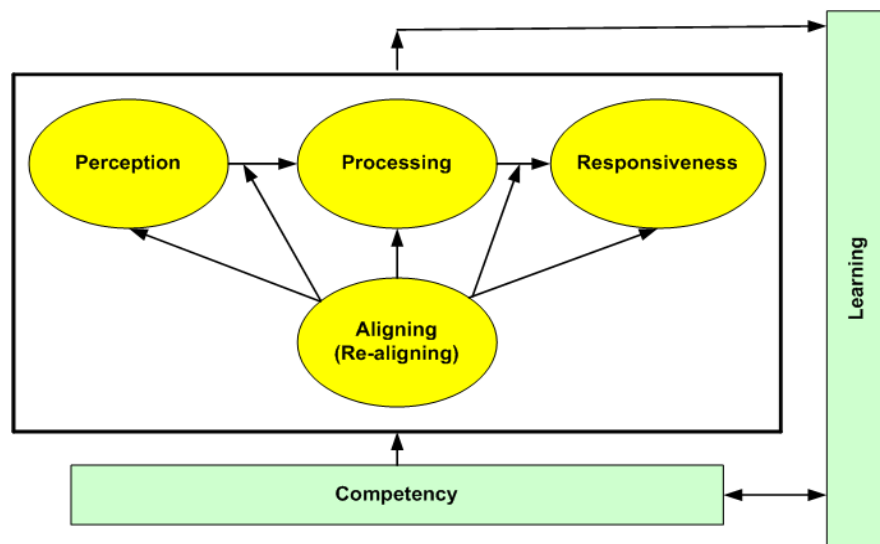
**Agility Requirements**

The agile organization must be mentally alert to identify the right direction to move and to sense conditions from the environment that call for changes to its posture. Ideally, the organization must be alert enough to see the signs of impending events well before their materialization to allow sufficient time to mobilize. When this is not possible, an organization must be able to re-organize itself on short notice to exploit future opportunities that result from those unanticipated events.

We assert that an agile organization should be able to: (1) identify signals from the internal and external environments in a timely manner, (2) process these signals, (3) respond adequately both reactively and proactively, (4) acquire and deploy competencies, in various domains, and in multiple combinations, with minimal effort in terms of time and cost, (5) define, monitor, and update goals and objectives as conditions in the environment changes, and (6) continuously learn to be better able (faster, more efficient, more effective) to do the above. Organizations that are unable to act accordingly are not agile, and they will, at best, only be able to react to changes in their environment in a rigid, haphazard, or slow manner. In the worst case, they may fail to react at all to the changes in their environment, resulting in their demise.

**Agility Model**

Organization agility can be thought of as comprised of the following components: perception, processing, responsiveness, aligning, learning, and competency (see figure 1). First, an organization must be able to perceive incoming signals from its internal and external environments. Next, it is important for an organization to process these signals, and respond adequately to them. Responding to information, both proactively and reactively, may require an organization to re-align its current goals and objectives in light of the new information. With every piece of new information that is processed, the organization has the opportunity to learn and improve its competency. Competency is the measure of reliability and maturity of an organization’s perception, processing, responses, aligning, and learning abilities. The agile organization will be able to move through this cyclical process in near real-time sequences.



**Figure 1: Organizational Agility Model**

The next section will describe each component of this model and discuss the role and the dark side of information technology relating to that component. Appropriate information technology can clearly support the needs of an agile organization if it meets the necessary requirements (Reich et al., 1999; Song et al., 1997). However, information technology can fail to

support agility for reasons that generally fall into two categories: inappropriate design such that the information technology does not meet those requirements; or the incorrect/inadequate usage of the tool or system.

## INFORMATION SYSTEMS AND ORGANIZATIONAL AGILITY

### Perception

Perception refers to the ability to sense changes in the environment. In order to do this optimally, the organization must have a good understanding of its internal and external environments; the sources it must pay attention to in order to receive signals; the type of signals to perceive; and the characteristics of those signals (e.g. frequency, strength, form, etc). Signals differ in their strengths and origins. It is easier for an organization to perceive strong and visible signals rather than those that are latent and weak. However, it is these very latent and weak signals that come back to haunt an organization in times of crises (Desouza, Hensgen and Evaristo, 2004). Signals that originate within ones locality, both physical (e.g. neighborhood) and logical (e.g. supplier extranet), are easy to perceive, compared to those that originate in remote or distant places. It would be unwise for an organization to limit itself to signals in its immediate vicinity, as we live in a global, complex, and inter-connected world, where small changes across the globe can have significant effects on our well-being (Axelrod and Cohen, 1999). The organization should also be able to retrieve signals from sources in a timely and cost-effective manner, using both push and pull strategies.

**Role of IS:** Information systems assist the perception of agile organizations by capturing large amounts of data and information. Search engines improve perception by providing the ability to scan vast environments for information. Prior to the advent of such technologies, one was limited to physical access to information (e.g. going to a library, asking a friend). Today, one can not only search the digital space for information, but can also query the people who are connected to the digital space through the use of chat rooms, discussion groups, etc. With RFID technologies, an organization can track and monitor the movement of assets and inventory with precision. Information can be retrieved from multiple sources, in multiple formats, and can be made accessible with limited compatibility issues. Appropriate use of these technologies makes available a multitude of signals to the agile organization.

**Dark side of IS:** The strength and power of these tools allow an organization to gather information in an almost costless manner which can create a problem. Most organizations are inundated with information from a multitude of sources at an ever increasing speed which creates an issue of noisiness. Valuable signals often get buried in huge amounts of noise. As an example, consider the case of the US Intelligence Agencies. These organizations had large amounts of technical information (i.e. those that were gathered from satellites, phone communications, etc). Yet, they were unable to perceive the threats in their environment (Desouza and Hensgen, 2005) because valuable signals got buried in the large amounts of information collected, much of which was noise. The ease of collecting information can lead an organization to feel a false sense of security that they are actually gathering the most relevant information to their environment. In reality the information being collected could distort perceptions or worse yet, make perceiving the environment difficult, if not impossible.

Lack of integration between an organization's data gathering systems can also inhibit perception. Most companies have implemented their information systems incrementally to solve specific problems that were important at some given point of time. This may lead to overlaps or gaps between the areas of perception. Overlaps imply inappropriate use of resources. Gaps imply areas where signals may not be perceived.

Finally, systems are usually optimized for their current business environment and thus tuned to receive signals relevant to that current business environment. The perception of those signals may be so strong that relatively weak but significant signals in new or unrelated areas may be missed or drowned out. This could cause the organization to miss upcoming opportunities.

### Processing

The ability to filter, evaluate and process incoming signals is crucial to an agile organization (Gunasekaran, 1998). Signals are raw and may be obscured by noise. If an organization reacts to every signal it detects, the organization could exhaust its resources on irrelevant signals or noise. An organization must initially filter the signals it perceives and then convert the remaining raw signals into accurate and up to date information to be used to drive decisions and actions (proactive or reactive). In the case of an agile organization, this processing must be accomplished quickly to respond to change in a timely manner. The organization may not have time to pre-process information (e.g. evaluate its quality) before putting it through processing cycles. However, before an organization can respond, it has to know what to respond to and must be confident that it is getting reliable information to process.

Processing cannot be handled by a priori mechanisms alone. It is difficult to predict future events reliably and consistently. Agile organizations need viscosity and fluidity to develop new processing routines when needed. It must be able to process information that it has predicted it needs, but also information that it has not predicted it needs.

**Role of IS:** Processing of information is one of the strengths of information systems. The ubiquitous presence of computing power in mobile and embedded environments creates the ability to access, update, and process information anywhere, anytime and anywhere. This has the potential of shortening the time it takes for managers of agile companies to be prepared to take actions. Agility is about improving that cycle time for managerial action (Prahalad, Krishnan and Ramaswamy, 2002).

Processing information also provides various views and perspectives of an underlying set of data. It also involves conducting analytics or business intelligence functions such as correlations, regressions, and trend analyses. More sophisticated applications provide latent analytics that seek to discover hidden patterns in information. Such analytic tools can be used for post-hoc, real-time, or predictive analysis. Post-hoc analysis is commonly used to develop a historical perspective as to why a particular situation arose and to prepare standardized historical reports such as financial statements, performance reports, etc. Real-time analysis calls for processing data as it comes into the organization — i.e., monitoring the sources of information in real-time and compiling or updating analytics instantaneously.

**Dark Side of IS:** Information systems also can detract from the ability of an organization to process the signals it perceives. These difficulties can be caused by inappropriate information systems (due to poor implementation or insufficient requirements) or by poor management decisions with regards to the application or use of those systems. In either case, the end result is that the information systems may work against an organization becoming agile rather than enabling agility. Data coming from different entities or from different contexts may have different data formats or incompatible communication systems. This adds to the time to convert and insert the information into the centralized database for processing.

The scope of the information systems processing can also be an issue. If the scope of the data that is being processed is too narrow, then sub-optimization can result which may impede an organization from achieving agility. Organizations with multiple divisions or branches are able to perceive very large amounts of data. But if their processing systems can only work with a narrow slice of that data, then the ability of that organization to respond will be limited. On the other hand, if data is over-generalized, “over-fit” or used in an inappropriate context, it may lead to inappropriate conclusions or improper actions. While one could argue that this is a failure on how the information system is used, ultimately it is still a failure of the information systems to support the need of the organization that desires agility.

## Responding

Once signals have been perceived and processed, the agile organization must quickly make an appropriate response (Archer, 1999; Sharifi and Zhang, 1999). Responses can be pre-determined (e.g. using previously calibrated actions), or created as new actions in response to the current stimulus. An agile organization should have the capability to determine when to use a previously calibrated action and when to construct a new action. In order to respond to information appropriately, the organization must be able to mobilize its knowledge resources in a timely manner and be able to access the organizational knowledge about previous related decisions and their rationale. Emergent teams may need to be created to synthesize expertise and bring it to bear on a given problem. Moreover, the organization should be able to acquire resources from business partners as needed to meet the needs of any given issue or stimulus.

**Role of IS:** Information systems can help in responsiveness by getting signals from one’s external environment in a timely manner and then quickly deploying decisions to those who are impacted. Consider the concept of supply chains. Demand fluctuations from the customers can be fed to the manufacturers who are upstream in the value-chain to help them better plan their production cycles. Just-in-time systems have been facilitated by information sharing systems. Interaction platforms such as virtual discussion groups, communication protocols, etc will need to be setup in near real-time to facilitate discussions, coordination, and control of actions.

**Dark side of IS:** The important decisions come from the decision makers using the information systems (not the information systems on their own). The perception and processing capabilities of a organization can overwhelm decision makers with the quantity of information they are getting, which means that organizations can perceive and process adequately but fail to respond in a timely manner due to the bottleneck effect of decision makers (Langley, 1995).

The dynamic business environment can cause the information systems to be out of date with the needs of current business conditions. Information systems usually require large investments. However, the reality is that business conditions are unpredictable and the embedded base of information systems can become obstacles to agility due to their inability to respond to the needs of the changing environment (Reddy et al., 2002).

Information systems often must be tuned to work with existing organizational processes and functions. To be agile, organizations need to be flexible. However, organizations often strive to achieve efficiency of their processes by optimizing the use of their information systems and processes thus creating a tension. The more robust and flexible a process (and underlying information system) is, the less optimized it is going to be as one has to account for the wide range of possibilities on how it will be used and implemented. An optimized process will be well-defined, hard-coded, and not amenable to changes, thereby impeding quick response to change.

### Aligning

Business environments change all the time. When an organization senses, processes, and responds to those changing signals, it may also need to re-evaluate and change the business goals and objectives. An agile organization must be able to adjust its entire organizational structure to align with those modified goals in a time-sensitive manner. (Coronado, 2003) These new goals, objectives, or organizational structures can then feedback and affect the need for sensing new signals. The resources of the organization must be reconfigured quickly to align with these new directions (Sambamurthy, Bharadwaj and Grover, 2003).

**Role of IS:** The rapid reconfiguration of resources may involve such activities as shifting inventories from one branch to another, scaling up production, reassigning a sales force, putting the brakes on an ineffective promotional campaign, or cross-selling among business units. Information systems play a key role in mobilizing and shifting those resources and supporting agility by enabling ad-hoc, distributed, and virtual work environments. Resources, both human and physical, can be brought to bear on given task environments from various locations. The control and coordination of project efforts can be greatly facilitated with information systems as well.

Web services are an example of a technology supporting an agile organization. They connect applications with one another by providing an interface for the exchange of information. The key aspect of web services is the concept of 'loose coupling' by which they are able to connect applications with little or no customization. Applications can quickly be connected across multiple platforms to enable sharing of technology resources easier. Two key concepts of web services that promote agility are 'openness' and 'modularity'.

**Dark side of IS:** Agile organizations have to adjust their business architecture to produce more attractive goods or service, or incorporate emerging technologies based on the dynamic business environment.. However, the existing information systems may not support the required changes in business configurations because they are optimized to the current business architecture. Employees are trained and comfortable using the existing information systems. This means that making changes to those underlying systems to achieve alignment may be a difficult challenge.

Externally, agile organizations need to engage other entities in horizontal business arrangements, which require some level of integration of disparate information systems. Rigid, inflexible information systems impede the ability to quickly establish the necessary information connections necessary for such arrangements to be successful.

Alignment and agility require one to assume that information systems are dynamic and not static. Many organizations view information systems as static investments that they buy once then forget about. Once the system is complete, most organizations only think they have to maintain an information system and forget about *transforming* it to meet new needs so as to keep the agile organization aligned.

### Learning

Learning is an important activity in organizations (Argote, 1999; Brown and Duguid, 1991; Cohen and Levinthal, 1990). Learning refers to the ability to build on experience so that the organization is continuously improving itself and is better prepared to deal with changing conditions in the environment. An agile organization must learn continuously and effectively from its internal processes so as to rid itself of bad practices and build on the good ones. A company that is adept at learning will also pick up technology, skills, and processes from any external partners. An organization learns and builds on all of its experience and learning itself becomes a competency. Agile organizations learn not only from achievements, but they also learn from their mistakes by recognizing the mistake and then quickly correcting it. .

**Role of IS:** The use of knowledge management systems have come to play a vital role in organizational learning. Using directory services (e.g. yellow pages, active directories, etc) organizations can manage expertise profiles of employees. Information systems can be used for distance education, training, etc. All of these may also help in building competencies and knowledge of the individuals within the organization. For example, an employee, working in customer service call center, can respond to customers' problems based on the basic training and her/his own experience with customers in the past. However, if there is a central electronic log book where all employees input customers' problems or complaints, that

knowledge database can be searched for similar problems. This allows the individual employee to learn faster and more effectively from this pool of employees' knowledge system rather than that individual's experience.

**Dark Side of IS:** We used to remember the lyrics of songs we liked and the phone numbers we occasionally called. Do we remember any of them now? No, our karaoke machines and our cell-phones remember all. Individuals can develop a dependency on their information systems such that they neglect learning new techniques, tools, or knowledge. This can suppress innovation or challenging the status quo when perhaps that is what is needed. A heavy reliance on information systems can result in rote operation of the operational processes institutionalized by those systems resulting in uninspired execution of those processes.

Information systems can also lead to less face to face or other forms of direct interactions between employees (as demonstrated by the employee who sends an email to their coworker in the next cubicle rather than talking to them). Information systems may bring efficiency because it reduces chatting between employees, but it also eliminates the opportunities for employees to get inspiration for innovation from more direct interactions..

Unlearning of bad practices is equally important for an agile organization. Static information systems may force an employee to continue to execute a flawed business process even though the employee knows it is flawed. Part of learning is abandoning or changing those things that no longer work and information systems can be an impediment to this. Clearly, this is not consistent with the need of agile organizations to effectively manage change.

### Competency

The components of the agility model described above - perception, processing, responsiveness, alignment, and learning - are affected by the competencies of an organization. Competencies include knowledge and experience about the market, and also knowledge and experience about processes for how to do things internally and with external partners (Sharifi et al., 1999).

Competency is related to all of these attributes working together. Organizational agility is not just based on each agile attribute, but is dependent on how well they work together.. For example, although an organization may have a great processing capability, if the data coming from perception is garbage, the organization is only processing garbage. If an organization has excellent separate sensing, processing, and responding systems, but they are not integrated as a system, the organization will have a difficult time achieving agility. Thus, organizational competency is how organizations as a whole can support and balance all of the agility components.

**Role of IS:** Information systems support organizational competency when the various systems supporting the different agility components can be integrated and work well with each other. The integration of the information systems must also support flexibility to deal with change. A flexible, robust set of information systems supports overall organizational competency and therefore agility. Without such information systems, it may be impossible to support the required business capabilities required for agility due to the complexity of organizational structures and business environments. The role of IS in competency is as the brain and heart for organizations to perceive, process, and respond to signals, while aligning with business goals and learning through those activities.

**Dark side of IS:** This is the most critical component for organizations if they are going to be agile. If organizations lack one of the other components in the model, steps can be taken to add or improve that component. However, if organizations don't have the necessary competency, the other components will be difficult to support or improve., Ultimately, without competency, the organization will eventually be out of business. The dark side of information systems is the degree to which the organization is locked-in to a static, difficult to change information system. If those systems are rigidly focused on yesterday and today's operations, they may be efficient, but they will not support the competencies that are necessary to be successful in today's dynamic, changing business environment. For example, an organization that has competency in providing great hardwired communication systems such as phones and faxes, may not have the competency to support today's employee mobility thus working against organizational agility.

### FUTURE RESEARCH, LIMITATIONS AND CONCLUSIONS

Research is needed to further our understanding of information systems and organizational agility. Additional case-related examples of both the positive and negative implications of information systems on organizational agility could provide additional depth to our understanding and then guide survey-based empirical research to further test that understanding. In particular, we would like to suggest that researchers take a critical view of current *management* approaches and *technological* solutions in terms of their contribution to organizational agility. For example, management approaches such as outsourcing of information systems can have advantages in terms of cost-saving and other economic benefits. However, they might restrict an organization's ability to function in an agile manner due to the specificities of the vendor's processes or barriers embedded



in the outsourcing contract. Similarly, technologies such as enterprise resource planning suites can have positive and negative impacts on organizational agility. Further research should also look at isolating the key dimensions of information systems that either support agility or cause rigidity and examining what actions information systems managers can take to move towards agility. In addition, research is needed to further our understanding of how an organization should balance between the seemingly contradictory demands of being agile and optimized. Optimization calls for being structured, systematic, and planned, while agile requires appreciation of chaos, dynamism, and emergence.

Nevertheless, a significant contribution of this paper is to open up the black-box of how information systems support organizational agility. Information systems have often been viewed as a helpful tool or enabler for organizational agility. The research provides a starting point to evaluate and improve information systems contribution to agility by not only increasing the bright side but also by decreasing the dark side. For practitioners, the paper provides an impetus to look not only at how information systems can help support organizational agility, but also at how they can suppress agility. The agility model presented here provides a basis for the future development of recommendations on how firms can overcome this “dark side” of information systems and agility. For researchers, this points out the need to further understand the components that lead to agility and the relationship with the organization’s information systems. Opportunities also exist to better understand the linkages between the agility components including any moderating or mediating influences. Ways of measuring organizational agility need to be developed and it opens up new avenues for researchers to look at organizational agility.

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