Future Research Challenges in Business Agility – Time, Control and Information Systems

Markus Strohmaier
Know-Center, Inffeldgasse 21a, 8010 Graz, Austria
mstrohm@know-center.at

Herwig Rollett
Know-Center, Inffeldgasse 21a, 8010 Graz, Austria
hrollett@know-center.at

Abstract

Today organizations face increasingly dynamic and competitive environments. Business agility aims to address these challenges. In this contribution, we aim to increase understanding about business agility by introducing a novel conceptualization. In addition, we aim to identify key research challenges that need to be addressed by future research. In order to achieve these goals, we first introduce different levels of analysis that explain how business agility integrates into existing organizational structures. Subsequently we define business agility to 1) be goal-oriented and 2) to represent a triadic problem consisting of the three dimensions time, control and information systems. Then we introduce an integrative concept of business agility that ties together the three dimensions and introduces parameters that enable an assessment of different degrees of business agility. Based on that, we identify two main research directions, organic information systems and decision support systems, which are of special relevance and importance in the quest for increasing business agility of organizations.

1. Introduction

Companies today find themselves in a highly dynamic and competitive environment. The only constant is change, and change happens ever more rapidly, and ever more often in the form of discontinuous upheavals rather than incremental changes. The very notion of the classical enterprise is being questioned, and alternative forms of organization, particularly flexible networks, receive a lot of attention. Little wonder then that business agility has emerged as a hot topic.

Information systems have played their part as a driver of change, and therefore as one of the reasons that agility has become so important in the first place. However, information systems can also help to meet these challenges. More than that, they sometimes even have the potential to meet several goals at the same time – for instance those of agility and controllability, which have often been perceived as conflicting in the past. This is all the more important because controllability will not evaporate as a goal: In the future, depending on how flexible networks develop as an alternative form of organizations, controllability will either become a required aspect of networks (e.g. for trust) or a differentiator of enterprises as a form of organization (which will still have a place, albeit no longer a virtual monopoly).

This paper provides a novel way for conceptualizing business agility and for identifying future research challenges in that direction. After clarifying the levels of analysis, the discussion of business agility is framed in terms of time, control and information systems. Cybernetics is introduced as a perspective offering new insights. Two research areas, organic information systems and decision support systems, are presented as examples demonstrating how research questions can be derived with the help of this new perspective. The overall contribution of the paper consists of both the new conceptualization of business agility and the research agenda identified.

2. Levels of Analysis

Before delving deeper into a new way of framing research on agility, clarity is required regarding the levels of analysis we are talking about. Beneath an overall business level, organizations typically consist of various departments such as production, marketing and IT. Of course *goals* exist on both these levels and are often related to each other. The kinds of *actions* we are concerned with, for example certain working practices or the introduction of a new system, occur at the departmental level and should always be related to a goal being pursued. In terms of goals, we are primarily interested in agility, which occurs both on the overall business level and on the departmental level. In addition, a distinction should made between *agility of information systems* and *agility through information systems* (IS). The agility of IS is not directly mandated by overall business goals – it generally only receives attention because an IT manager realizes that this will help with achieving other goals the department is expected to meet, for instance keeping costs down. Agility of IS can therefore be important even in companies which do not consider overall business agility as one of their goals. By contrast, agility through IS means enabling overall business agility with the help of IS. If agility is considered a goal at the business level, then the various departments are expected to contribute to it – for example the IT department by contributing to agility through IS. Further goals are of interest here insofar as they impact the pursuit of agility in some way. We will see that controllability is one such goal.

Two examples should help to illustrate this. An executive information system generally is not considered an agile system, but it can help to achieve the goal of agility *through* IS by providing executives with better access to more up to date information as a basis for speedier decision. As a second example, consider service oriented architectures, which contribute to the agility *of* IS by reducing adaptation costs.

3. Business Agility is a Triadic Problem

An early application of agility in industrial contexts was Agile Manufacturing [10], which aimed to make efficient and well-structured enterprises more flexible and adaptable. The concept of agility, from Latin agilis, from agere to drive, act [17], focuses on timely and adequate (re-)actions to/for the unexpected [21]. The term *unexpected* here includes both reactions to *known* and *unknown* situations, events or triggers. In the following, we define business agility to represent a triadic problem oriented towards specific goals (as depicted in Figure 1).

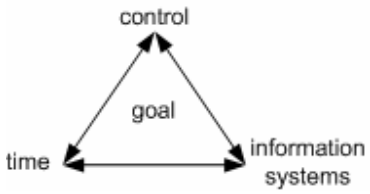

Figure 1. The triadic problem

Business Agility is a Time Problem: What makes business agility a novel approach compared to existing approaches is the focus on *time* as the critical measure of success. Organizations that fail to be agile, fail to react (adequately to given circumstances) *in time*. A telecommunications company that did not introduce mobile telephony or broadband internet as one of its services in time (by the end of the nineties) *failed to be agile*. A software company that offers web services that cannot be integrated with client systems in a reasonable amount of time *fails to be agile*. These examples powerfully illustrate why any assessment of agility in organizational contexts has to consider the time restrictions imposed by given circumstances. Based on this argumentation, we define business agility to be a *time problem*. The time dimension itself can further be divided into four components of latency (similar to a distinction of latencies made by [21]): 1) Decision latency is the time an organization needs to decide on adequate actions, 2) action latency is the time needed to perform the envisioned actions, 3) impact latency is the time the environment needs to react and 4) perception latency is the time it takes to perceive the outcome of taken actions.

Business Agility is a Control Problem: Furthermore, we define business agility to be a control problem. A lack of control (similar to the notion of "discipline" by [3]) prevents organizations from executing adequate actions in time. A start-up company with weak or missing control mechanisms that fails to accurately and timely implement an adequate business strategy fails to be agile. Thus, control focuses on the adequateness and effectiveness of actions with respect to a certain goal. A well-established research domain that focuses on the exploration of control in a broad range of domains such as biology, artificial intelligence, philosophy, psychology and sociology is cybernetics [1,6]. From a cybernetics perspective, a control system only perceives what points to potential disturbances of its

own goals and comprises the following activities [11]: perception, information processing, action and dynamics (as depicted in Figure 2).

According to cybernetics, a control system makes decisions based on an explicit or implicit goal and a constructed representation of an environment. These decisions lead to certain actions that affect the environment and subsequently its observable variables. The control system perceives the changes and adapts its representation of the environment. An evaluation of this representation with the targeted goal reinitiates the control process. In the context of business agility, cybernetics represents a profound theory and fundament for the understanding of control in complex business environments.

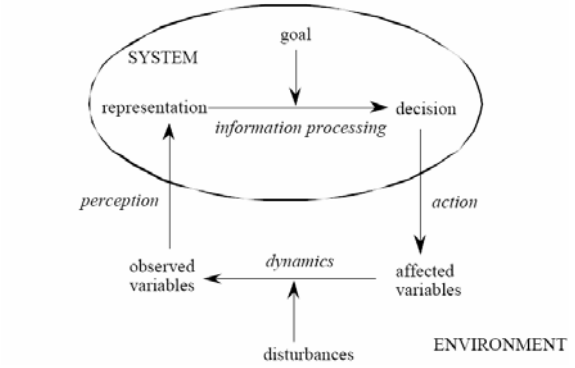

Figure 2. Components of a control system [11]

Business Agility is an Information Systems Problem: Business operations become more and more information- and knowledge intensive today. This development will transform the way organizations do business in the future. Information systems, and their increasing ability to support knowledge-intensive work, therefore represent a key factor for organizations to remain competitive. Because non-aligned organizational and technological systems can cause friction or even failure in business operations, business agility requires not only aligning business and information systems but also considering the effects of change over time. A global consulting company that does not have adaptive, business-aligned knowledge management software available today *fails to be agile*. Information systems have several implications on business agility: Information systems have both descriptive and normative components that influence an organization's ability to be agile. Also, information systems represent an important interface with an organization's environment. They increasingly determine the way an organization perceives its environment and thereby represent a critical component in decision making processes. Information systems also act as a buffer (in a cybernetic sense [11]) at this interface and therefore co-determine the organization's borders and self-perception. Because information systems act both as an en- and disabler of business agility, we finally define business agility to be an *information systems problem*.

4. Conceptualizing Business Agility

Figure 3 illustrates a new concept for business agility tying together the three dimensions of the introduced triadic problem. Because agility is goal-oriented, the concept is based on the cybernetics thinking approach. In cybernetics the adequateness of perceptions, actions and decisions represents the basis for achieving goals. Therefore the parameters Q_p, Q_d and Q_a represent the quality of decisions, actions and perceptions with respect to the goal of the control system. In addition, agility is a time problem. Therefore we introduce the parameters Δ_p, Δ_d, Δ_a and Δ_i that represent the latency of decisions, actions, impact and perceptions. The additional parameter D_i represents the degree of impact of taken actions on the environment.

> The introduced parameters determine the degree of business agility for an organization. Therefore, a maximum degree of business agility can be achieved by minimizing latency and maximizing quality parameters. Thus, business agility (BA) can be described as $BA = f(\Delta_p, Q_p, \Delta_d, Q_d, \Delta_a, Q_a, \Delta_i, D_i)$.

It is important to note that while Δ_d and Q_d are properties of the control system, Δ_a, Q_a, Δ_p and Q_p are properties of both the control system and the environment. Δ_i and D_i are exclusive properties of the environment and can (if at all) be manipulated only indirectly. This distinction leads to the conclusion that the level of business agility is not only dependent on an organization itself, but on the environment as well, which is a reasonable assumption since aspects of environments that cannot be manipulated may prevent organizations from being agile such as legal regulations or global restrictions. Therefore, an organization's ability to be agile is limited. An organization can only be agile to the extent its environment permits it.

Information systems have significant multi-dimensional implications on business agility. Today, the majority of control systems in business contexts are driven by humans respectively functional units that are increasingly supported by information systems.

Information systems thereby have the potential to improve both the latency and quality parameters of business agility. Therefore, current research on information systems can be categorized into one of the following directions.

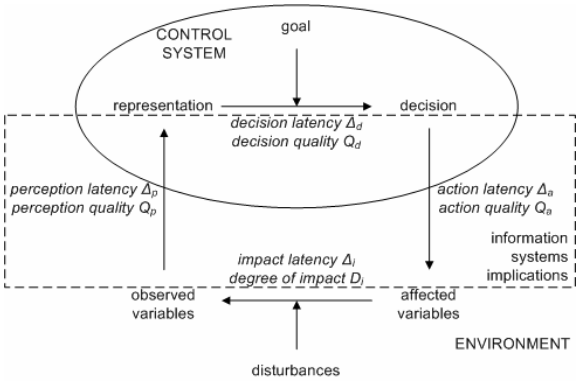

Figure 3. Business agility conceptualization and parameters

The first direction aims at providing more comprehensive support for human control systems through information systems while maintaining and strengthening human qualities. Examples of such efforts include current awareness tools, decision support systems [12] or project management software.

The second direction aims at delegating certain aspects of control to information systems. Here again a distinction is necessary: Information systems can on one hand take over certain activities (such as perception, decision making or action execution) of control systems. This leads to information systems-enabled perception (e.g. business intelligence tools, management dashboards), decision (expert systems) or action (e.g. automation) instruments. Business agility is achieved *through* (respectively supported by) information systems. On the other hand, information systems can implement a whole control loop in well defined areas of application. Based on our definition of business agility, information systems here have to pursue a certain goal. This is the only situation where we can classify information systems as being agile *themselves*[1]. The (business) agility *of* information systems is the main concern of research efforts here. Examples of research heading towards this direction represent agent technologies (in the context of e.g. e-marketplaces), organic computing [20] or artificial life.

5. Future Research Challenges in Business Agility

Although the introduced conceptualization of business agility motivates a broad range of future information systems research challenges, we'd like to focus on two selected research directions that bear tremendous potential to revolutionize the way information systems are applied in business contexts: Organic information systems and decision support systems.

5.1. Organic Information Systems

Organic computing is a rapidly emerging field of research. It aims to apply principles of biology to software systems. Organic systems are goal directed and have so-called self-X properties such as self-configuration, self-protection or self-organization [20]. Furthermore autopoiesis [16] is a particularly interesting property that, in brief, describes a systems ability to produce and maintain itself. [19] defines organic systems to be: "*... organic if all of its components and subsystems are well coordinated in a purposeful manner. Organic structures realize themselves as hierarchically nested processes, structured such as to be able to meet upcoming challenges by goal-oriented reactions.*" This definition strikingly relates to the concept of business agility. Organic systems are realized as *nested processes*, thereby addressing the *control problem* of business agility. They focus on *goal oriented (re-)actions* and are aligned to meet upcoming challenges and thereby address the *time problem* of business agility. This interesting analogy powerfully illustrates the huge potential of *organic systems* in the context of business agility. The second important argument for the pressing need for research at the intersection of business agility and organic computing is the explicit goal of organic computing to develop organic concepts up to a maturity level where they can be utilized in technical applications [20].

What Constitutes Organic Information Systems?

With the aforementioned arguments in mind, we introduce the following definition of organic information systems:

[1] In fact the implementation of goals in information systems with respect to the business agility parameters distinguishes true agility from other properties such as flexibility, adaptability or modifiability.

"Organic information systems are software systems that are 1) goal-oriented and 2) employ organic principles through imitating certain aspects of living systems in order to increase the agility of organizations and/or institutions. Organic information systems both act autonomously and interact with human or artificial agents."

By following this definition, organizations and/or institutions can achieve agility through the application of organic information systems. This definition has some important implications for future research on organic information systems: First of all, research needs to establish sufficient understanding about the principles of organization in living systems [20] and the application of these principles in software systems. Related research areas such as philosophy, biology and artificial intelligence already provide a comprehensive basis for research on particularly promising aspects of living systems in an information systems context. Secondly, since organic information systems are expected to achieve goals, research on adequate and feasible goals in an organizational context needs to be performed. This is a particularly important aspect since the possibilities and limitations of organic systems are not well understood yet. Thirdly, concrete functionalities of organic information systems [9] need to be envisioned, developed and shaped that aid in imitating certain aspects of organic behaviour of living systems. Fourthly, information and communication technologies that provide organic information systems functionality need to be investigated, developed and/or applied. Fifthly, feasible concepts and scenarios for the application of organic information system functionalities that indeed enable organizations to increase their level of agility need to be developed [8]. Developing answers to these challenges would significantly contribute to realizing the vision of information systems enabled, agile organizations by improving the parameters of business agility introduced in this paper.

On the Importance of Knowledge in Organic Information Systems

Knowledge represents a critical and multi-dimensional factor in organic information systems. Organic information systems not only need to have knowledge about their environment (e.g. the organization, its structure, actors or partners), but they need to have knowledge about themselves as well [20]. This includes knowledge such as knowledge about goals, options or heuristics for taking actions. In addition, organic information systems need to have knowledge about what kinds of situations or representations demand what kinds of actions with respect to certain goals. Learning, the (re-)construction and development of such knowledge, is another obvious and critical property of organic information systems. Beyond that, organic information systems need to exchange knowledge with both artificial and human agents. Thus, communication and accompanying research domains such as agent technologies, human computer interaction, knowledge visualization [4], knowledge retrieval [13] and knowledge management systems [14, 15] need to be investigated for potential stimuli. Many of these domains can be summarized into the more general scientific domain of knowledge management that can be regarded to provide relevant concepts for the challenges emerging from the concept of organic information systems.

5.2. Decision Support Systems

As a second example, we shall have a look at decision support systems which are of interest in the context of this paper because of their potential to contribute to *agility through IS*. The second reason why decision support systems are pertinent here is because they can also provide aspects of *controllability* and are therefore an example showing not only that agility and controllability need not always be seen as conflicting with each other, but that it is in fact possible to support both at the same time.

An obvious way to compare different decision support systems is to consider the degree of automation they offer. This question can elegantly be framed with the help of the notion of decision criteria, which are the rules being applied in specific situations [7]. While constraining the spectrum of choices, decision criteria allow for degrees of freedom, whereas a specific decision results at the point where the degrees of freedom have been narrowed down to zero. Seen from this angle, decision support systems, as the term is understood today in its mainstream sense, are really about managing various kinds of decision criteria, but do not autonomously make decisions on their own. They are thus about providing more comprehensive support for human control systems. Viewed through our concept of business agility, the central purpose of such systems generally is to improve decision latency Δ_d and/or decision quality Q_d. This already raises a meta research question, answers to which will help to further determine promising future avenues of research: *From an overall business agility perspective, should technology support*

for human decision making processes focus more on speed or on decision quality?

An important factor in this context is whether the system in question is meant for supporting individuals or groups. In particular, while there has been much hype regarding systems asynchronously supporting virtual groups, there is also research which suggests that computer-mediated communication can actually decrease group effectiveness, increase the time required to complete tasks, and decrease member satisfaction [2]. Since there is an unmistakable trend towards networked but flexible and distributed forms of organization for which business agility will be particularly important, this begs two research questions related to human computer interfaces: First, *How can computer-mediated communication be designed to avoid poorer results compared to face to face decision support systems?* Second, *Which logical and visual representations of information are best suited for supporting decisions made by (1) individuals and (2) large and/or frequently changing groups?*

Recent research on decision making also recommends expanding the search for alternatives by putting more effort into (a) expanding the arena of action, (b) increasing the clarity of objectives and (c) using multiple perspectives to uncover more options [18]. This is of course very much in line with the philosophy behind business agility. In terms of our conceptualization of business agility, (b) and (c) concern the decision quality Q_d, while (a) is an issue of improving perception quality Q_p. Perception latency Δ_p is rarely addressed by today's decision support systems. Perception quality can sometimes be improved with their help, but this will usually happen not through specific features of the system for that purpose, but rather by using available tools within the system (e.g. brainstorming components) to cover a broader territory. This raises the following important research question: *Given that one can never completely understand one's environment, how can systems help to improve both the quality and the latency of perception as a prerequisite for better decision making?*

Returning to the distinction of different kinds of decision support by their degree of automation, we now turn our attention to systems which actually delegate certain aspects of control from human decision makers to systems. While not very widespread yet, such systems are becoming increasingly more common [5]. Obviously, they dramatically reduce decision latency Δ_d. If they are afforded the means to execute the decisions as well (as in the case of some automated trading systems), they reduce action latency Δ_a in an equally dramatic fashion. Action quality Q_a may stay the same ($1m traded is $1m traded, whether by a human or by a machine), or it may improve through automation (in cases where precision is key). There are of course also actions whose quality depends a lot on human soft factors, but these are generally not the object of automated decision making. To what extent such systems can improve decision quality Q_d is an open issue. Anecdotal evidence suggests that this is possible in some contexts, where expert systems achieve better results than human experts, while in other contexts like strategic management fully automated decision making is completely out of the question. This leads to a two-tiered research question: *In which contexts is the full automation of decision making (1) possible in principle and (2) economically feasible within the next 10 years?*

Perception latency Δ_p can also be drastically improved through completely automated systems provided that the variables in question can be measured without human intervention. Improving perception quality Q_p is a much more difficult proposition. The particularly relevant issue of expanding the arena of action, as mentioned above, not only requires systems exhibiting a high level of intelligence – which might be provided by artificial intelligence research – but also granting these systems autonomous access to a vast variety of data sources and sensors, since it cannot be predicted which variables the system will decide to measure. The research question here touches upon sensitive social and political issues: *To what extent are people willing to empower autonomously acting systems with access to public and personal data and sensors, and what are the ensuing risks?*

Finally, decision support systems cannot directly improve impact latency Δ_i or degree of impact D_i of a given action. However, as has been discussed, decision support systems can broaden the scope of actions considered and may therefore indirectly increase the overall impact. This train of thought leads to an interesting big picture research question: *In which ways can a focus on high impact decisions contribute most to business agility, and how can such a focus best be supported through IT?*

6. Conclusions

We have introduced a new conceptualization of business agility. Based on this, we have presented two main research areas that promise to be of special relevance in future research on business agility: Organic information systems comprise autonomous information system functionality that is goal-oriented and imitates certain aspects of life, while decision support systems support and strengthen human qualities in human control systems.

We conclude that even if the term "business agility" should turn out to be a management fad, we believe that the underlying problems of time, control and information systems will remain a challenge for both academia and industry because of an economic environment that is dominated by dynamic change and increasing uncertainty.

7. Acknowledgements

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