MARCEL VAN OOSTERHOUT

Business Agility and Information Technology in Service Organizations

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Before I started to work on my PhD, I had always admired other people who worked as a PhD candidate and successfully finished and defended it, based on more than four years of hard work. It looked like a challenging, long and tough journey, sometimes even requiring some selfishness, which requires perseverance and focus. On the other hand it appeared to be a creative process with lots of freedom, where you develop and test new ideas, combine different perspectives and work on a concrete product: the thesis. I have experienced the journey as such and I feel very lucky to have been given the freedom and guidance to do so.

My first acquaintance with PhD research was during a student assistantship in 1995 and 1996 with Martijn Hoogeweegen. Martijn worked on his dissertation on Modular Network Design. Together we developed a tool to assess costs and benefits of IT in business networks and applied it to a case study in the port of Rotterdam. Based on my Masters thesis I wrote an article together with Martijn that received the Telematics Student Award 1996. We used this prize to participate in a study trip to Silicon Valley, USA in 1997. This was the start of my interest in the role of IT and how it can enable organizations to create competitive advantage. It also triggered my interest in global travelling. Many thanks Martijn for the valuable and unique experience!

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In 2004 I moved to the Department of Decision & Information Sciences, where I was employed as project manager/scientific researcher. In this department I started to develop my first ideas to conduct PhD research in line with the research projects on which I was engaged in connection with my personal research interests. Since 2005 these ideas became more concrete and Eric van Heck and Peter van Baalen kindly offered to be my promotor and co-promotor. Thank you both for your patience, your belief in my capabilities and your perseverance. When we had another meeting with too many pages of text and pictures, you took the time to bring me back to the core of my research. After each meeting, I was inspired and full of new ideas to further strengthen the quality of the dissertation. Eric, you taught me the importance of consistency, logic, focus and simplicity. Peter, thanks for our discussions to deepen my initial descriptive manuscripts. I really appreciate working with you in the challenging research projects of our department!

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Marcel van Oosterhout May 2010, Rotterdam

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Chapter 1: Motivation and problem statement

1.1 A turbulent and uncertain world

For long times business environments were relatively stable with changes taking place incrementally (Kidd, 2000). When a radical change occurred, the pace tended to remain relatively slow, and was not quickly followed by other significant changes. In these relatively stable environments organizations were not urged to be adaptive or pro-active to respond with speed to internal and external events. Most of the changes and events in the business environment were predictable and to a large degree certain. However, technology innovation, long-term public policy shifts and deregulation are destabilizing the business landscape and reshaping the world in which we live (Hagel and Brown, 2003). In particular, the Internet as a communication and transaction infrastructure has led (and will lead) to turbulence and uncertainty in the business and consumer markets. The Internet has the potential to connect everyone and everything. Friedman (2005) claims that the globalized world of the twenty-first century has made the world flat. Radical "nonlinear change" which brings about a different order is becoming more frequent. Furthermore the pace of change is significantly more rapid. Business networks have become more complex and interwoven. Interrelated supply and demand chains require coordination among different organizations (Klapwijk, 2004). On one hand there is the trend to blur industry boundaries (finance, media, telecom and information technology are converging) (Bradley and Nolan, 1998). On the other hand re-intermediation creates new actors with new capabilities, providing new services to the final customers. Regulatory changes and external requirements for accountability, sustainability and security have enormous impacts on organizations' products, processes and resources. As an example, in the Dutch energy market deregulation requires energy companies to unbundle products and services. Customers demand prompt service 24x7 via multiple channels and high levels of responsiveness to handle last-minute changes. In order to remain competitive and persist as a business over time, the ability to sense uncertain events, to respond quickly and to learn from the experience is increasingly important (Dove, 2001).

In different industries we witness large differences between the ability of firms to sense highly uncertain and unexpected events and swiftly respond by changing businesses and business processes. Some firms seem to be more agile and responsive than others. Firms with high levels of business agility performance are capable of sensing and responding quickly to uncertain events in their environment and breaking the rules of the game by broadening (or shrinking) specific aspects of their capabilities or reducing cycle times beyond existing levels of flexibility (Sengupta and Masini, 2008). Two examples illustrate this. In the fashion industry Zara moves new apparel designs from concept to store racks within a two-week time window, whereas other traditional retailers such as H&M have a restrictive nine-month design-to-delivery window (McAfee *et al*., 2004). Apparently, Zara is capable to sense changes in customer demands and quickly respond with new apparel designs. Another example is the agility of information technology (IT) service companies, which was put to the test during the recent financial crisis in 2008. When IceSafe bank, an Iceland based bank came into financial problems, from one day to another clients could no longer access their internet savings accounts via the internet. This led to significant panic among customers of IceSafe and other banks across Europe. Customers wanted some kind of assurance that their money was still safe and could be accessed via the internet. From one moment to another the Icesafe bank website and account information were no longer accessible for clients. This also led to peak load traffic on websites of other banks. IT companies that provide the hosting capacity and technology maintenance services for banks like Icesafe were required to respond quickly to maintain access to the online banking services of their clients. How well was this event sensed and how quickly could the IT companies respond? Had they learned from previous similar unexpected events?

These two examples illustrate the growing importance of business agility in turbulent markets, which are characterized by highly uncertain and unexpected events. IT can be an important enabler for business agility. In the case of Zara, the information systems (IS) of Zara support quick changes in product design, supplier selection, raw material acquisition and production and distribution schedules. Electronic point of sale (EPOS) data and other information from all of the company's stores and sites around the world provide direct information from the market (Christopher, 2000). In the example of the Icesafe Bank the use of intelligent agent software helped the IT service company to sense a possible disruption of their web hosting service in an early stage. This triggered a response process and avoided a possible disruption of the online banking service. Both examples illustrate how IT can improve responsiveness and agility. This dissertation analyzes the role and impact of information technology on business agility of service organizations in response to highly uncertain and potential consequential events.

1.2 The role of Agility

To deal with the flattening world and to cope with challenges like those discussed in the previous section firms require increased levels of responsiveness. Responsiveness can be engineered into organizations, processes and systems via flexibility, but only to a certain extent. All flexibility which is engineered into a system, up-front, costs a lot of money. A new concept is required to break the rules of the game and remain the winner in the current marketplace. This concept, called agility, has its origin in the US car manufacturing industry in the early nineteen-nineties. In the US there were concerns about the decline of the US manufacturing industry and loss of competitiveness. The Department of Defense instructed academics at Lehigh University to develop a vision, framework and recommendations for creating a successful industrial base. This resulted in the publication of a report entitled twenty-first Century Manufacturing Enterprise Strategy (Goldman *et al*., 1991), published by the Iacocca Institute at Lehigh University (Kidd, 1994). After this initial report, the Agility Forum was established by a number of researchers to further explore the agility concept. Agile manufacturing was developed as a new manufacturing paradigm for dealing with changes in customer requirements when markets are volatile. Agile manufacturing “assimilates the full range of flexible production technologies, along with the lessons learned from total quality management, ‘just-in-time' production and ‘lean' production” (Goldman and Nagel, 1993).

Goldman *et al*. (1991) defined agility as *the ability to thrive in a competitive environment of continuous and unanticipated change and to respond quickly to rapidly changing, fragmenting global markets that are served by networked competitors with routine access to a worldwide production system and are driven by demand for high-quality, high-performance, low-cost, customer-configured products and services*. The work of Goldman *et al*. (1991, 1995) was followed by a series of publications on agile manufacturing and agile corporations (Kidd, 1994; Kidd, 1995; Dove, 2001). Later, the concept was extended to supply chains and business networks (Christopher, 1992; Mason-Jones and Towill, 1999; Van Hoek *et al*., 2001; Swafford, 2003; Yusuf *et al*., 2004). More recently a number of researchers have analyzed how Information Technology (IT) can enable business agility and the way in which agility can be incorporated in the development of information systems (Sambamurthy *et al*., 2003; Desouza, 2006).

1.3 How IT influences Business Agility

IT is a major force driving the need for business agility and at the same time an important capability, which can hinder or enable a firm’s level of business agility. Over time, IT has developed and matured significantly. IT was relatively expensive in the early days of computing. Efficiency was the primary objective shaping the architecture, while delivering relatively limited performance. Roles and relationships were tightly defined to optimize use of scarce and expensive technology resources (Hagel and Brown, 2001). During the years IT has become standardized and commoditized, leading to lower prices due to economies of scale. The literature provides three streams of research with different perspectives on the relationship between IT capabilities and business agility (performance). The first stream claims that IT capabilities do not really matter or even hamper business agility performance. The second stream claims that IT capabilities contribute to higher levels of business agility (performance). The third stream claims that IT capabilities contribute to higher levels of business agility (performance), but only under certain conditions and for certain events. This PhD study will provide evidence for the third stream.

1.3.1 IT as barrier for Business Agility

Researchers have found contrasting and sometimes even conflicting results on the effects of IT on responsiveness and organizational agility. In an analyses of a number of cases on business process reengineering Attaran (2004) found '*IT to be the biggest barrier to rapid and radical change, because radical change required IS redesign*'. Hard-wired IT architectures where business rules are embedded into the information systems are a major impediment to rapid movement. Such architectures are expensive to maintain and have difficulties to support smaller, incremental modifications to business practices (Hagel and Brown, 2003). Information infrastructures in companies often mirror the functional silos within the organization, where business logic is tightly linked to independent data sources in legacy applications (Prahalad *et al*., 2002). As a solution, many companies have replaced their fragmented unit silos with enterprise wide Enterprise Resource Planning (ERP) systems. However, these systems are designed for vertically integrated corporations. Although these ERP systems enable companies to share data horizontally crossing different functional departments, this has resulted in more integrated but relatively inflexible architectures, where companies are locked into rigid business processes (Hagel and Brown, 2001). ERP systems contain many options and interrelated pieces, which means more complexity (Rettig, 2007). Such IT systems are based on "top-down" paradigms and do not support the new demands of the business environment (Klapwijk, 2004). To summarize, quality and accuracy of information is relatively low, implementation of new Information Systems (IS) takes relatively long and complexity is too high. Once implemented, corporate wide IS tends to paralyze business processes.

These results are confirmed in a study by Harris Interactive, commissioned by AT Kearney (2005), which showed that IT departments within larger organizations are perceived as not being very agile and being unresponsive. Main obstacles found are legacy IS, too much complexity in the IT architecture, a lack of integration between business and IT (i.e. insufficient Business-IT alignment) and differences in views between business and IT leaders on the importance of IT and the timing of new technology adoption. The complexity of heterogeneous IT infrastructure and applications prevents IT organizations from developing and deploying new systems quickly to support business agility requirements (Reddy and Reddy, 2002).

1.3.2 IT as enabler for Business Agility

Current IT limitations place constraints on the agility level of organizations. However, it is expected that new technologies and innovations in various layers of the IT architecture make agility more attainable (Melarkode *et al*., 2004). Some examples of these innovations are shown in Figure 1.1. IT can be an enabler for business agility if IS are based on open standards (enabling easy switching among partners), if they use best-of-class within functional areas and if they are highly adaptable to change (i.e. agile), due to short implementation timeframes and limited replacement or disposal costs (Klapwijk, 2004). The agility of IT is increasingly supporting enterprise adaptability (i.e. business agility). The focus of automation has shifted from the back-office (1980s) to the front-office (1990s) to automation of IT infrastructure's ability to adapt to every business decision (today). Functional (vertical) IT architectures are replaced by horizontal (enterprise wide) IT architectures.

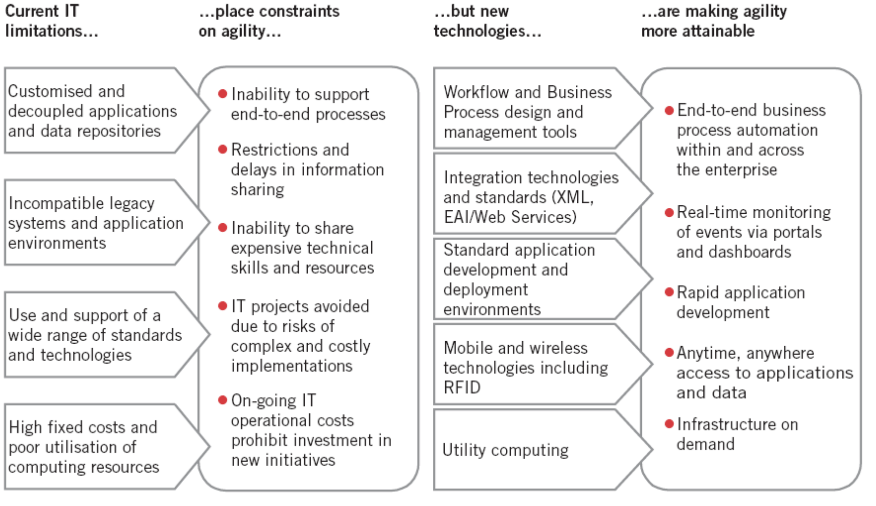

Figure 1.1 – IT from hindrance to enabler of business agility (Melarkode *et al.* , 2004)

Several consultancy firms and IT vendors have developed concepts and strategies to help organizations achieve IT agility and business agility (see Table 1.1). All use their own definitions to describe their vision of business agility and how IT can enable business agility, adaptive supply chains and business networks. They provide a variety of organizational concepts and agile IT solutions designed to achieve the proper level of business agility in order to handle unexpected waves of change. Many books have been written on the immediately responsive organization designs enabled by IT: *Real Time* (McKenna, 1997), *Adaptive Enterprise* (Haeckel, 1999), *The Horizontal Organization* (Ostroff, 1999), *ZeroTime* (Yeh *et al*., 2000), *Response ability* (Dove, 2001). Many scholars preach the enabling role of IT capabilities to enhance business agility (Goranson, 2000; Haeckel, 1999; Moitra and Ganesh, 2005; Umar, 2005). The common idea is an agile organization that can configure its resources and people quickly and which is flexible enough to sense and respond to changing demands, enabled by IS in general and Internet-based IT infrastructure in particular (Umar, 2005; Pearlson and Saunders, 2006).

Table 1.1 - IT and consultancy firms' concepts for enhancing business agility

Organization	Concept	Definition
IBM	On-Demand Sense-and Respond Organization	An enterprise whose business processes—integrated end-to-end across the company and with key partners, suppliers, and customers- can respond with speed to any customer demand, market opportunity, or external threat (Mitchell *et al*. 2003).
Hewlett-Packard	Adaptive Enterprise	The Hewlett-Packard vision for helping customers to synchronize business and IT to capitalize on change. Its foundation is laid down in the Darwin architecture (Hewlett-Packard 2003).
CapGemini	Adaptive IT	Transforming the entire enterprise in order to make it more agile, flexible and more capable of adapting to a constantly changing market environment. Adaptive IT affects five dimensions of activity: infrastructure, information, applications, processes and organizational structure (Cap Gemini 2002)
Gartner	Real-time enterprise	Real-time enterprise achieves competitive advantage by using up-to-date information to progressively remove delays in the management and execution of its critical business processes (Boyd 2002).
Cordys	Agile enterprise	Cordys helps organizations achieve business agility by combining the business process components with a process-centric, event-driven, service-oriented architecture (SOA) and combines business process modeling, business performance monitoring, and composite application development and deployment into a single environment (van Donge 2007).

The third stream of research claims that IT capabilities contribute to higher levels of business agility (performance), but only under certain conditions and for certain events. The effects of IT capabilities on business agility and business performance are mainly indirect and mediated by sensing, responding and learning (Overby *et al.*, 2006). The benefits of IT Infrastructure agility are lagged, because new applications that leverage new infrastructure take time to deploy, and important organizational factors such as time for learning and decision-making governance mediate their implementation and use (Aral and Weill, 2007). Tallon (2008) points at the managerial IT capabilities that lead to the development of technical IT capabilities associated with agile IT infrastructure, which in turn drives business agility or a firm's ability to react to change in its products and markets. An important moderating factor in the relationship between IT capabilities and business agility is business-IT alignment (Luftman, 2000, 2003; Ross *et al*., 2006).

1.4 Motivation

Managers increasingly feel the need to have a sufficient level of business agility performance to react in an agile way – proactively or reactively – to uncertain internal and external events and opportunities. The problem is that businesses are not always designed to cope with large uncertainties and unpredictability. Business practices are grounded on the assumption of certainty and predictability (Kidd, 2000). Information systems are also not designed to cope with uncertainty and unpredictability. Therefore, for many companies IT is a major factor that hinders the required level of business agility. In InformationWeek's Research Outlook 2006 survey two in five managers cite improving their business agility as a key IT objective (McGee, 2006). Research of Forrester shows that that fewer than half of CEOs have any confidence in IT as a contributor to business success (Tucci, 2007). A survey of MIT among 1508 IT executives shows that 71% of US companies are in stage 1 or stage 2 of enterprise architecture maturity (Ross *et al.*, 2006). This can explain why IT hampers business agility in many companies.

Insufficient agility levels have various negative effects on business performance, for instance due to delays in new product introductions. For example, in the pharmaceuticals and cosmetics industries, Foster and Kaplan (2001) calculated a six-month delay in product introductions represents greater than 30% reduction of lifetime product revenue. Having IT capabilities that enable business agility can provide companies competitive advantage by shortening time to market for new products. As an example, Zara moves new apparel designs from concept to store racks within a two-week time window, whereas other traditional retailers struggle with inflexible IT and a restrictive nine-month design-to-delivery window (McAfee *et al*., 2004). The IT systems of Zara support quick changes in product design, supplier selection, raw material acquisition and production and distribution schedules. Electronic Point-of-Sale (EPOS) data and other information from all of the company's stores and sites around the world provide direct (sensing) information from the market. Advanced IT couples Zara's highly automated factories with a network of more than 300 small subcontractors, each specializing in one particular part of the production process or garment type. As another example, General Electric expects to save $10 billion by 2006, using real time information from their GE Cockpits, to monitor business performance and adapt quickly to required changes (Melarkode *et al*., 2004).

1.5 Research objective and research questions

The topic of this dissertation is to analyze and explain the impact of IT on business agility performance of service organizations in relation to highly uncertain and unexpected but potentially consequential events. The objective of the dissertation is to create an explanatory framework that illustrates how and under which conditions IT supports service organizations to sense and respond to uncertain events buttressed by learning capabilities. A service is defined as *useful labor that does not produce a tangible commodity* (Webster Dictionary). Two features that distinguish service organizations from manufacturing firms are the intangible and perishable nature of the output and the closeness of the consumer to the producer (Mills and Margulies, 1980). The producer of the service (the employee) and the customer interact in order for the delivery of the service to be complete. The central research question of this dissertation is:

What is the role and impact of IT on business agility of service organizations in response to uncertain events?

Table 1.2 provides an overview of the sub research questions for this study and the chapter(s) in which they are discussed.

Table 1.2 - Research questions

Research Question	Chapter(s)
1. How can business agility and business agility performance be defined and measured?	2
2. How can (a lack of) business agility performance be explained?	2
3. Which events cause a business agility gap (i.e. for which events do firms perceive a deficiency in the required level of business agility performance) and is there a difference between different industries?	4,5
4. How do IT capabilities impact business agility?	2,3, 6
5. Which elements comprise the (transition towards) an agile IT architecture?	4
6. What IT strategies exist for enhancing business agility?	5
7. Is there a relationship between the type of event uncertainty and the use of sensing, responding and learning capabilities?	6
8. How do sensing, responding and learning capabilities influence business agility performance?	6

1.6 Scope and focus

The effects of IT on business agility can be analyzed at different levels. Inspired by Hoogeweegen (1997) and Bakos (1987) six possible levels of analyses can be defined. The *individual* level relates to the individual employee working in an organization. The *single organization* level relates to how internal activities should be organized and linked in order to create a margin between the value created and the costs made (Porter, 1985). The *dyad* relates to two organizations that have a relationship, e.g., a seller and a buyer (Davis, 1993). The *supply chain* relates to 'the chain linking each element of the production and supply processes of products and services from suppliers to the end-customer' (Scott and Westbrook, 1991). The *industry* level relates to 'a group of firms that offer a product or a class of products that are close substitutes to each other' (Kotler, 1988). Finally, the *(business) network* level relates to a network that consists of 'nodes' or *positions* (occupied by firms) and *links* manifested by interaction between the positions (Thorelli, 1986). Kambil and Short (1994) define the business network as 'the structure of interdependent relationships between the activities of a given firm and those of other firms in its competitive environment that influence each other's strategies'.

Business agility performance of service organizations depends on IT support for the completion of tasks by individual people, the specialization of internal capabilities in the firm, and the interaction of customers and partners in the design and delivery of the service (Sambamurthy *et al*., 2003; Mills and Margulies, 1980). There is a trend to outsource different components which influence the level of IT agility, such as IT infrastructure (e.g. cloud computing), applications (e.g. Application Service Provisioning and Software as a Service) and even complete business processes (Business Process Outsourcing), to partners in the business network. This underlines the growing importance of partnering agility. The first and second empirical study will explore the relationship between IT and business agility at the organizational level within a specific industry setting (energy, finance, logistics and mobile telecom). The third study will explore the relationship in more depth at the organizational and individual level within four IT service units of IBM Benelux.

1.7 Research design

The research design of this dissertation consists of three phases. Phase 1 contains an extensive literature study and analysis of existing case studies (Chapters 2 and 3). This results in an overarching research model. In phase 2, a broad analysis of the agility concept is made across different industries and public sectors based on the overarching research model. Research methods used include surveys and case studies with interviews (two studies, resulting in Chapters 4 and 5). In order to get a comprehensive picture and to understand the complex organizational phenomena associated with business agility we will work from a pluralistic methodological stance. This way, the risk that we only highlight one aspect of the phenomenon under study is reduced (Knudsen, 2003; Mintzberg and Campbell, 1999). The use of multiple methodologies also enables us to provide a richer and more reliable understanding than any one approach by itself (Van de Ven and Poole, 2005; Mingers, 2001). In phase 3, an in-depth analysis is made of the different elements of the framework in order to come to a number of testable propositions. This analysis is based on a multifaceted case study within four IBM units (resulting in Chapter 6).

The use of various research methodologies helps to achieve triangulation (i.e. seeking to validate data and results by combining a range of data sources, methods and observers (Mingers, 2001:244)). Using multiple methods adds to the richness and validity of the results. The case studies sacrifice breadth for depth (Gill and Butler, 2003), while the surveys enables us to draw more generalizable conclusions.

1.8 Relevance and contribution

This research has relevance and contributions for both the scientific community and the business community. Using the classification of Gregor (2006) on types of theories, we can position this research as primarily analytic (type I theory) and explanatory (type II theory). This approach will yield an explanation of how, why, and when IT is related to business agility (performance) from the perspective of multiple varying views of causality and methods for argumentation. This research aims to promote greater understanding or insights into business agility dimensions, IT capabilities and the relationship between IT capabilities, business agility and business agility performance in relation with uncertain events. The research will provide testable propositions, which other researchers can use to develop and research justifiable causal explanations.

The managerial contribution of this research project is to provide managers insight into the event types that can cause a need for agility, the conditions under which IT can support a firm’s sensing, responding and learning and the potential personal and organizational frictions and rigidities, which can hamper business agility performance. The results should also provide managers objective insights, trade-offs and building blocks for designing and managing IT as a means for business agility.

1.9 Outline

The overall structure of the PhD thesis is described in Figure 1.2. Chapter 2 provides a literature review on business agility and information technology (IT) agility while also exploring the relationship between IT capabilities, business agility and business agility performance. Chapter 3 discusses a number of case studies and in conjunction with a literature study, describes the role and impact of IT capabilities on business agility.

Existing research in the field of business agility focused mainly on manufacturing firms. Limited research has been done on the application of agility within firms that primarily deliver services to customers. There is relatively little research so far on the reasons why firms need to be agile and the (perceived) lack of business agility performance. Many authors assume the need for agility, without analyzing in more detail specific external and internal event types requiring agility. This omission in the existing literature will be researched in the first empirical study (Chapter 4). Chapter 4 is based on two cross-industry surveys which were conducted in 2004 and 2005 among 110 managers in 4 profit and 3 non-profit industries. The surveys focused on identification of events that led to a need for agility in various industries, the agility gaps (high perceived need for agility and low perceived business agility performance) and the perceived effects of IT on business agility and business performance. The surveys were complemented with in-depth interviews with 50 managers.

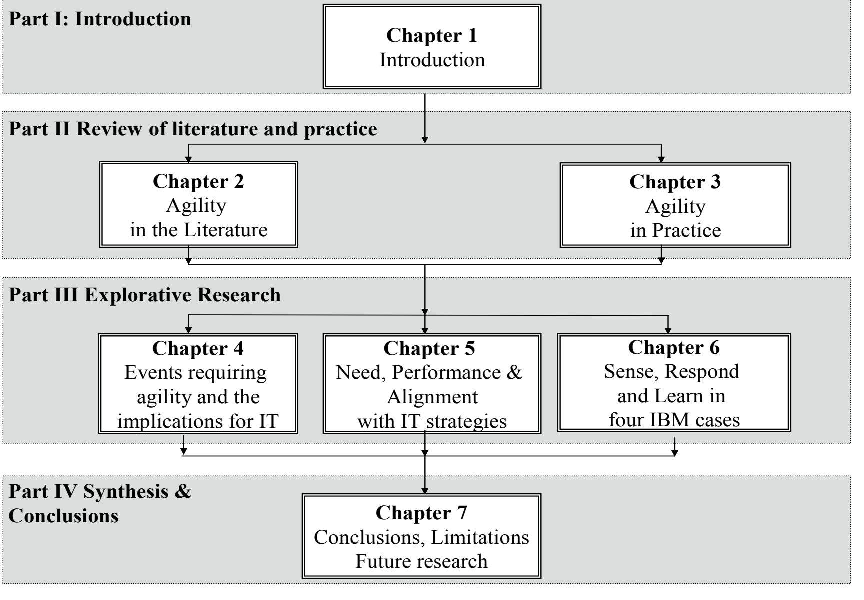

Figure 1.2 - Structure and building blocks

Chapter 5 is based on the same two cross-industry surveys of Chapter 4. The difference of this Chapter compared to Chapter 4 is the detailed analysis of differences between operational, partnering and customer agility and the exploration of IT managerial strategies to close the gap between required business agility and existing business agility performance.

Chapter 6 explores the relationship between event uncertainty, IT capabilities, business agility and business agility performance in more detail. It distinguishes events with different types of uncertainty and how these relate to different business agility dimensions. A measurement instrument is developed to assess the maturity of sensing, responding and learning dimensions at an organizational (business unit) level. This measurement framework is validated in a multifaceted case study within four business units of IBM Benelux.

Chapter 7 discusses the key findings of this dissertation, the limitations, the contributions to the academic world and the business world and the recommendations for future research.

Chapter 2: Agility in the Literature

2.1 Introduction

In the tradition of Blumberg *et al*. (2005) the purpose of this literature review is four-fold. First, the literature review establishes the context of business agility and the role of IT by referencing previous work. Second, the review is used to understand the structure of the research problem and theories related to the problem. Third, the review identifies the relevant variables and relations between IT and business agility. Finally, the review is used to synthesize and gain an overall perspective on the problem.

The literature review is structured as follows. Section 2.2 introduces and defines the concept of business agility, explores why firms need to be agile, introduces range and time as two requirements for agility, discusses how firms can enhance their business agility, based on three groups of dynamic capabilities: sensing, responding and learning. Section 2.3 discusses the concept of IT agility from a structural design perspective based on the different layers of the enterprise architecture. Section 2.3 also analyses the agility of Information Systems and the different types of IT capabilities that support sensing, responding and learning. This section concludes with a discussion on business-IT alignment. Section 2.4 explores the relationship between IT capabilities, business agility and business agility performance by presenting a critical review of recent empirical studies. Section 2.5 summarizes the results of the literature review and presents a framework that identifies how business-IT alignment coupled with sensing, responding and learning capabilities yields an impact on business agility performance.

2.2 Business Agility

2.2.1 What is business agility?

History of the concept

Business Agility is a management concept to cope with the competition, business practices and corporate structures of the twenty-first century. Business (or Enterprise) Agility builds upon other concepts in management theory that pertain to firm success in turbulent environments. These concepts include dynamic capabilities (Teece *et al*., 1997), market orientation (Kohli and Jaworski, 1990; Narver and Slater, 1990), absorptive capacity (Cohen and Levinthal, 1990; Zahra and George, 2002), and strategic flexibility (Ansoff, 1980; Volberda, 1998; Grewal and Tansuhaj, 2001).

The concept originated in the US in the early ninety-nineties as a new manufacturing concept and a next step after LEAN and Flexible production concepts. US Congress was concerned about the loss of competitiveness of the US manufacturing industry. In 1990 a task force was set up by the Department of Defense (DoD) to develop a new perspective on making the US manufacturing industry more competitive. The DoD asked academics at Lehigh University to develop a vision for a successful industrial base. This resulted in the publication of a report entitled twenty-first Century Manufacturing Enterprise Strategy (Goldman *et al*., 1991), published by the Iacocca Institute at Lehigh University (Kidd, 1994). After the initial report the Agility Forum was established by a number of researchers to further explore the agility concept. Agile manufacturing was developed as a new manufacturing paradigm for dealing with changes in customer requirements in volatile markets, by using a number of different agile responsive manufacturing concepts. Agile manufacturing "assimilates the full range of flexible production technologies, along with the lessons learned from total quality management, 'just-in-time' production and 'lean' production" (Goldman and Nagel, 1993).

Goldman *et al*. (1991) define agility as *the ability to thrive in a competitive environment of continuous and unanticipated change and to respond quickly to rapidly changing, fragmenting global markets that are served by networked competitors with routine access to a worldwide production system and are driven by demand for high-quality, high-performance, low-cost, customer-configured products and services*. The Agility Forum proposed four strategic dimensions of agile competition (Goldman *et al*., 1995). The first dimension is enriching the customer, which means providing product-information-service combinations as solutions for individual customers, priced on the basis of the value of the solution for that customer in the specific context (contextual value). The second dimension is to cooperate internally and (partner) externally with other companies. Third, organizations need to be organized to master change and uncertainty on the basis of an innovative and flexible organization structure. The fourth dimension refers to leveraging the impact of people and information by rewarding innovation and creating a thinking and learning environment. Agile manufacturing "assimilates the full range of flexible production technologies, along with the lessons learned from total quality management, 'just-in-time' production and 'lean' production (Goldman and Nagel, 1993).

The work of Goldman *et al*. (1991, 1995) was followed by a series of publications on agile manufacturing (Kidd, 1994; Sharifi and Zhang, 2000; Dove, 2001). Later, the concept was extended to organizational strategic agility (Conboy and Fitzgerald, 2004; Sambamurthy and Zmud, 2004; Dove, 2005; Overby *et al*., 2006) and supply chain agility (Christopher, 1992; Mason-Jones and Towill, 1999; Van Hoek *et al*., 2001; Yusuf *et al*., 2004). More recently a number of researchers have analyzed how information systems can enable organizational agility and the way in which agility can be incorporated in the development of information systems (Sambamurthy *et al*., 2003; Desouza 2006).

Flexibility versus Business agility

Dealing with change has always been an important issue in organizations. In areas where change is rather predictable and the response can be engineered upfront, organizations need to be flexible. Volberda and Rutges (1999) define flexibility as '*the degree to which an organization has a variety of actual and potential managerial capabilities, and the speed at which they can be activated, to increase the control capacity of a management and improve the controllability of the organization'* (Volberda and Rutges, 1999:101). Another definition of organizational flexibility is *the organization's ability to adjust its internal structures and processes in response to changes in the environment* (Reed and Blunsdon, 1998). Volberda (1998) distinguishes three types of flexibility: operational flexibility (referring to reactive routines to familiar changes that are based upon existing structures or goals of the organization), structural flexibility (referring to the capacity of the management to adapt its decision and communication processes within a given structure as well as the rapidity by which this can be accomplished) and strategic flexibility (referring to the capacity of the management to react to unstructured non-routine unfamiliar changes that have far-reaching consequences and need quick response).

Blackhouse and Burns (1999) observe that the boundary between flexibility and agility is blurred. Flexibility is defined as a predetermined response to predictable events with relative low to medium rates of change, while agility entails an innovative response to unpredictable events with relatively high rates of change. Flexibility is focused on single systems (e.g. manufacturing), while agility is focused on groups of systems (such as a supply chain or business network) (Whadhwa and Rao, 2003). The overlap between flexibility and agility could be described as *strategic flexibility*. Agility can be seen to envelop and extend the concept of strategic flexibility (Overby *et al*., 2006). Agility is needed when the required changes were not envisioned when the organizational processes and systems were established. As a result, more radical and innovative change is required such as modularizing or re-engineering existing processes and systems, building new systems and competences or acquiring these via external partners. Only organizations that can quickly and easily deal with this can be called agile. Agility and its capabilities cannot be achieved overnight. It should be built into the long range planning of the organization and mechanisms are required to maintain it over time (Ashrafi *et al*., 2006).

Definition

Even though much has been said and written on agility, a consensus on a definition of business agility has not yet emerged. Webster's dictionary defines agility as "*nimbleness*", "*the power of moving quickly and easily*" and "*the ability to think and draw conclusions* *quickly*". Agility can be a property of an individual, an approach (e.g. software development), a resource (such as information technology), an organization, a supply chain or even a business network. Being agile is defined as *being able to swiftly change businesses and business processes beyond the normal level of flexibility*. Table 2.1 provides an overview of definitions on agility, business agility or enterprise agility, found in literature.

Table 2.1 - Definitions on business agility

Term	Definition	Reference
Agility	The ability to thrive in a competitive environment of continuous and unanticipated change and to respond quickly to rapidly changing, fragmenting global markets that are served by networked competitors with routine access to a worldwide production system and are driven by demand for high-quality, high-performance, low-cost, customer-configured products and services.	(Goldman *et al.*, 1995)
Agility	The ability to detect opportunities for innovation and seize those competitive market opportunities by assembling requisite assets, knowledge, and relationships with speed and surprise.	(D'Aveni, 1994), (Goldman *et al.*, 1995)
Agility	The ability of enterprises to cope with unexpected changes, to survive unprecedented threats from the business environment, and to take advantage of changes as opportunities.	(Sharifi and Zhang, 2000)
Agile enterprise	A fast moving, adaptable and robust business. It is capable of rapid adaptation in response to unexpected and unpredicted changes and events, market opportunities, and customer requirements. Such a business is founded on processes and structures that facilitate speed, adaptation and robustness and that deliver a coordinated enterprise that is capable of achieving competitive performance in a highly dynamic and unpredictable business environment that is unsuited to current enterprise practices.	(Kidd, 2000)
Business agility	The ability of an enterprise to develop and exploit its inter- and intra-organizational capabilities.	(Hooper *et al.*, 2001)
Agility	The successful exploration of competitive bases (speed, flexibility, innovation pro-activity, quality, and profitability) through the integration of reconfigurable resources, and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast changing market environment.	(Ramasesh *et al.*, 2001)

Term	Definition	Reference
Adaptive enterprise	Adaptive enterprises sense and respond to environmental changes, learning from their actions how to change their behavior for next time.	(Cap Gemini Ernst & Young, 2003)
Agility	The continual readiness of an entity to rapidly or inherently, proactively or reactively, embrace change, through high quality, simplistic, economical components and relationships with its environment.	(Conboy and Fitzgerald, 2004)
Agility	The ability of a firm to continually sense and explore customer *and marketplace* enrichment opportunities and respond with the appropriate configurations of capabilities and capacities to exploit these opportunities with speed, surprise, and competitive success.	(Sambamurthy and Zmud, 2004)
Agile systems	Systems concerned with response abilities, for both reactive and proactive response needs and opportunities, when these are unpredictable, uncertain, and likely to change.	(Dove, 2005)
Business Agility	The use of existing IT and business process capabilities to rapidly generate new business value while limiting costs and risks.	(Ross, 2008)

The different definitions on business agility include terms such as change, unanticipated and unexpected, speed and quickness, reconfigurable and adaptable, monitoring and sensing, pro-active and reactive response, innovation, learning, inter- and intra-organizational capabilities. Agility is dynamic, open-ended and context specific (in time and space). What is presumed to be agile today, may be non-agile tomorrow. In short, business agility is defined as follows:

> Business agility is *the ability of an organization to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected but potentially consequential internal and external events, based on the capabilities to sense, respond and learn*.

2.2.2 Why do organizations need agility?

The level of agility businesses need will vary across companies and industries. The Law of Requisite Variety (Ashby, 1956) states that "*the variety within a system must be at least as great as the environmental variety against which it is attempting to regulate itself*". Any effective system must be as agile as its environment forces it to be (Dove, 2005). Especially high clock-speed and information intense industries such as electronics, financial services, pharmaceuticals and tele-communications are characterized by many environmental changes and uncertain events (Fine, 1998). In these hypercompetitive industries, agility is critical to a firm's continued prosperity (Sambamurthy *et al*., 2000). Eisenhardt and Bourgeois (1990) talk about high-velocity environments *''...in which rapid and discontinuous change occurs in demand, competition, technology, or regulation in such a way that information is often inaccurate, unavailable, or obsolete*'' and these environments *''...involve continuous instability overlaid by sharp spikes of discontinuous change''* (Eisenhardt and Bourgeois, 1990:74). In such high-velocity environments different events can lead to a need for agility.

We define event type as *an internal or external event that influences the need for business agility*. Table 2.2 presents a list of external and internal event types and examples of potential events within these categories. All are based on earlier studies on agility and related topics. We labeled the different event types E1 to E7. The following event types are defined as external events (adapted from Sharifi and Zhang, 1999): catastrophic events (such as natural disasters, fires), social/legal events (such as (de)regulation), business network events (such as competitors' mergers), competitive environment events (such as cost pressure in the market), customer needs (such as fundamental shifts in customers' tastes and demands) and technology events (such as opportunities for new business models due to technology innovation). Internal events that influence the need for business agility are either required changes with unexpected consequences spurred by external events or internally initiated events with unexpected consequences (e.g. a new strategy, restructuring of internal IT systems, mergers and acquisitions etc.) that require the organization to adapt fundamentally.

Each event is accompanied with a certain level of uncertainty. We define event uncertainty as *the type of uncertainty that accompanies an event and influences the need for business agility*. The classification of Milliken (1987) is used to distinguish three types of perceived uncertainty: state uncertainty, response uncertainty and effect uncertainty. State uncertainty refers to *unpredictability whether or when a certain event will happen*. Response uncertainty is defined as *a lack of knowledge of response options for the event and/or an inability to predict the likely consequences of an innovative response choice*. Effect uncertainty relates to *the inability to predict what the nature of the impact (i.e. effects) of an event will be on the organization*. Specific factors and relationships may be well understood, the interaction of competing forces over a number of iterations creates unexpected and unpredictable outcomes (Lengnick-Hall *et al*., 2004). Some events are quite predictable (e.g. deregulation in the telecom and energy industries). However, often the speed and exact requirements to the organization and processes are quite uncertain and therefore flexibility is insufficient.

Table 2.2 - Overview of potential external and internal events requiring agility

Event Type	Examples of events that lead to a business agility need	Related literature references
E1 Catastrophic events	• Emergencies / disasters (such as earth quakes, hurricanes)	
E2 Social/legal	• Deregulation • Legal/political pressures • Increased need for financial Transparency	(D'Aveni, 1994) (Gartner Research, 2003) (Sharifi and Zhang, 1999)
E3 Business Network	• Competitors' mergers in the market • Takeovers by competitors • Consolidations in the business network • Partnerships & collaboration between competitors	(Porter, 1980) (Van Weele, 2001) (Best, 2001)
E4 Competitive Environment	• Increasing pressure on cost in the market • Responsiveness of competitors to changes • Increasing rate of change in product models and product lifetime shrinkage • Threat of entry of new stakeholders	(Porter, 1980) (Sharifi and Zhang, 1999) (Swafford, 2003) (Volberda, 1998) (Goldman *et al.*, 1995)
E5 Customer Needs	• Demand for customized products and services • Need for quicker delivery time and time to market • Increasing expectation of quality • Sudden changes in order quantity & specification • Fundamental shifts in customer tastes	(Goldman *et al.*, 1995) (Sharifi and Zhang, 1999) (Da Silveira *et al.*, 2001) (Swafford, 2003) (Maskell, 2001)
E6 Technology	• New business models due to the introduction of wireless connectivity • Emerging technologies to easily connect to partners' information systems • Increasing number of viruses and cyber crime	(Swafford, 2003) (Gartner Research, 2003) (Vervest and Dunn, 2000)
E7 Internal events	• Restructuring of internal IT systems and support • Mergers and acquisitions	(Gartner Research, 2003) (Simon, 2000)

The event type and associated event uncertainty can lead to a need for business agility. Business agility need is defined as *the need for an organization to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events.* Ross (2008) makes a distinction between four different types of business agility need. Business efficiency agility is *the exploitation of capabilities to improve efficiency, reliability and security*. New product agility is *the exploitation of capabilities to develop and launch new products and services*. Business transformation agility is *the* *exploitation of capabilities to restructure/redesign or develop new business processes with the aim to enter new markets, open new channels, respond to new customer or partner demands, or implement new regulatory requirements*. Boundary spanning agility is *the exploitation of capabilities to grow profitably through acquisitions or partnerships*.

2.2.3 Requirements for agility: range versus time agility

Recent research of Sengupta and Masini (2008) distinguish range and time as two dimensions that can be made agile. Range agility represents *an organization's ability to broaden (or shrink) specific aspects (range) of its capabilities (*Sengupta and Masini, 2008). Adjustments in range can be implemented based on internal options (for example, better integration in processes or strategic business units), and external options (for example, via alliances and partnerships). Range-agility provides firms with the ability to add variety to its products, routines and practices, as well as to create and sustain webs of collaborative relationships with extended reach. A good example of a company that exploits range agility as a competitive weapon is National Industrial Bicycle Company of Japan (NIBC). In the early nineties NBIC, Japan's second largest manufacturer of bicycles, exploited a strategy where two manufacturing paradigms were simultaneously used: mass-production and mass-customization (Kotha, 1996). Customers could customize their bicycle by choosing from about eight million possible variations, based on different features such as model types, colour and flame size. The superior returns of NBIC were based on the range agility of their IT systems. These systems enabled interaction between the mass production and mass custom factories and encouraged knowledge creation. Another example of range agility is Amazon.com. The flexibility engineered into the supply chain of their logistics partners provides the customers of Amazon.com the choice for a time-window for delivery of a book ranging from 24hrs (relatively expensive) to 72hrs (relatively cheap). Amazon.com has exploited range agility by offering a new service in collaboration with external partners. This service delivers books as an e-book within a time window of 10 seconds. This example shows a strong compression of cycle time, while variety was added to the existing products and routines of Amazon.com.

Time agility is *the speed of response i.e. the time it takes to retool one's capabilities* (Sengupta and Masini, 2008). At the heart of agility is the concept of speed and time – the capability of an organization to rapidly execute decision making, operational cycles and reconfiguration of corporate structures (Canter, 2000; Conner, 2000; Palethorpe, 2003). Time is relevant for various metrics, such as time to market of new products, time to process an order or service request, time to assemble virtual business network collaborations, and time to reconfigure organizational processes and systems. The time dimension can be divided into four components of latency (Verstraete, 2004). Decision latency is the time an organization needs to decide on adequate actions. Action latency is the time needed to perform the envisioned actions. Impact latency is the time the environment needs to react. Finally, perception latency is the time it takes to perceive the outcome of the actions taken. Organizations with lower levels of latency will be more agile than organizations with higher levels of latency. Time agile companies can seize opportunities and gain advantages through their ability to reconfigure processes and organizational resources faster than competitors. An example of a company that exploits time agility as a competitive advantage is Zara. Zara is one of Spain's most successful and most dynamic apparel companies, producing fashionable clothing that appeals to an international target market of those between the ages of eighteen and thirty-five (Christopher, 2000). The information systems (IS) of Zara support quick changes in product design, supplier selection, raw material acquisition and production and distribution schedules. Electronic point of sale (EPOS) data and other information from all of the company's stores and sites around the world provide direct information from the market. Zara owns a number of highly automated factories and uses advanced IS to collaborate with a network of more than 300 small subcontractors, each specializing in one particular part of the production process or garment type.

Another example of the importance of time agility is time to market of products in the consumer products industry. The IBM Global CEO Study 2006 (IBM, 2006b) linked business performance and growth directly to the ability to bring superior products and services to market in a cost-effective manner. Reducing time-to-market was one of the key success factors. In some consumer product segments, product introduction cycles have changed from three new products per year to over 30 new products every month. This requires time agility. The study of IBM provided three requirements for reducing time-to-market. First, one of the most critical activities in new product introduction is acquiring an explicit definition of customers' requirements, in collaboration and communication with customers (i.e. customer agility). Second, the use of componentization (modularity) and standards to develop variations on products can help companies achieve "faster-to-market" objectives at lower costs. Third, an efficient product launch requires integration and coordination among multiple functional areas within the organization and the leveraging of core capabilities of other companies (i.e. partnering agility).

The research of Sengupta and Masini (2008) identifies two restrictions on the extent to which a firm can extract benefits from range or time agility. First, the interaction between range- and time-agility is negative. This means that firms that use a combination of both types of agility for creating value are likely to experience difficulty in doing so compared to firms that make a deliberate choice. Second, companies can derive additional value from progressive increases in range- or time-agility only up to a certain point. After this, higher levels of time- or range-agility can be counterproductive to organizational performance. In the case of range-agility, information overload can reduce organizational performance. In the case of time agility, over-exploration and reconfiguration reduces exploitation of existing resources. Therefore, for certain time- or range windows firms do not need to be agile (e.g. bakeries are not expected to be agile to bake their bread within 2 seconds). There are boundaries to the required level of time agility (< t1) or range agility (> r2), beyond which investing in extra agility has no use. Figure 2.1 schematically illustrates how agility envelops and extends the concept of strategic flexibility (Overby *et al.*, 2006) in relation with response time (t2 → t1) and response range (r1 → r2). Time-agility is more likely to provide benefits in highly dynamic environments, while range-agility is more appropriate for markets with lower levels of dynamism and unpredictability (Sengupta and Masini, 2008).

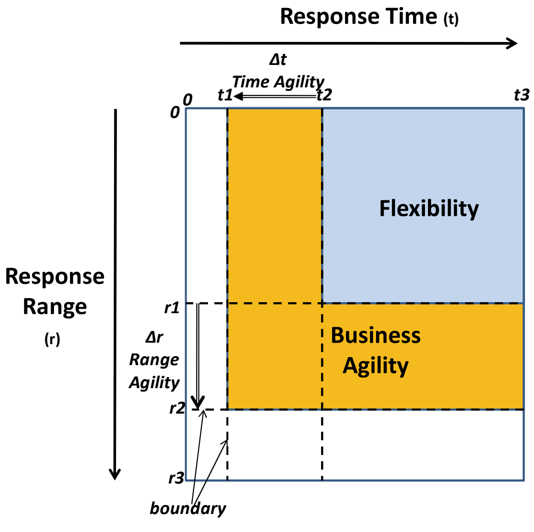

Figure 2.1 – How business agility envelops and extends flexibility on response time and response range

2.2.4 How to be agile: sensing, responding and learning

Introduction

The Dynamic Capabilities Perspective (DCP) refers to the ability of a firm to achieve new forms of competitive advantage by renewing competences—organizational resources—to achieve congruence with the changing business environment (Teece *et al.*, 1997; Eisenhardt and Martin, 2000). Capabilities are *dynamic* because the firm must continually build, adapt, and reconfigure internal and external competences to achieve congruence with the changing business environment when time-to-market and product timing are critical, the rate of technological change is rapid, and the nature of future competition and markets are difficult to determine (Teece *et al*., 1997). This theory is closely related to the fundamentals of agility. Dynamic capabilities are processes – specifically the processes to integrate, reconfigure, gain, and release resources — that use resources to match and even create market change. In short, dynamic capabilities are *organizational routines through which firms achieve new resource configurations* (Eisenhardt and Martin, 2000). Teece *et al*. (1997) define dynamic capabilities as '*the ability to integrate, build, and reconfigure internal and external competences to address rapidly-changing environments'*. Their advantage lies in applying them sooner, more astutely, or more fortuitously than rivals (Eisenhardt and Martin, 2000).

Agile organizations possess three groups of dynamic capabilities for mastering change and uncertainty: sensing, responding, and learning capabilities (adapted from Dove, 2001). Organizations develop dynamic capabilities over time through a series of linked strategic decisions about investments in information technologies and the blending of information technologies with organizational processes and knowledge (Barua and Mukhopadhyay, 2000). Dynamic capabilities can be organized and sourced internally and/or externally (see section 2.2.5 for a more extensive discussion on how dynamic capabilities can be sourced). The three groups of dynamic capabilities for mastering change and uncertainty are discussed below.

Sensing

> Sensing is *the ability of organizations to actively seek out and gather useable data, assimilate this into information (by filtering it for relevancy, timeliness, accuracy and content), interpret and analyze the urgency, causes and impact of the derived information and as such, anticipate or detect opportunities and threats in the business environment* (adapted from Kohli and Jaworski, 1990; Dove, 2001).

Different firm capabilities may be required to sense different types of change. Examples of such capabilities include market intelligence, policy lobbying, R&D capabilities and IT capabilities (adapted from Overby *et al*., 2006). The direct involvement of customers in product development – so called customer sensitivity – can be an important basis for sensing (Van Hoek *et al*., 2001; Maskell, 2001). Market sensitivity or customer sensitivity means being capable of reading and responding to real (time) demand. Organizations use supply chain management strategies such as Just-in-Time and Efficient Consumer Response in combination with Point-of-Sale data from RFID tags and barcodes to sense changes in real-time demand and respond quickly (Christopher and Towill, 2001; Van-Hoek *et al*., 2001; Yusuf *et al*., 2004).

One of the challenges for sensing is the sense-making process to handle possible sensing overload. Apparent noise needs to be converted into meaning and only those (possibly weak) signals that are relevant should be picked up and responded to. A dilemma is that managers are insufficiently aware of cognitive and emotional biases that can cloud their judgment when interpreting weak signals (Schoemaker and Day, 2009). Examples of personal biases are selective perception, rationalization, wishful thinking, egocentrism, fundamental attribution bias and selective memory. Also organizational level biases can cloud judgment when interpreting weak signals. Organizational sense making occurs in a complex social environment in which people are not just sensitive to what is being said, but also to who is speaking (source credibility). Social biases will be especially strong, when the information is weak or incomplete. Tools which can be used to amplify interesting but weak signals are testing of multiple alternative hypotheses, developing diverse scenarios and canvassing the wisdom of the crowd. The research of James Surowiecki (2004) shows that groups or markets often make far better judgments than individuals. This can be exploited during sense-making.

Responding

Responding is *the ability of an organization in collaboration with its customers and partners in the business network, to quickly and seamlessly (re)configure combinations of capabilities to shape innovative moves with relative ease* (Dove, 2001).

Agility expands the options for response when unpredictable events occur. It does this principally through infrastructure, systems, and business processes that are structured for *response ability* (Dove, 2001). Agile corporations are able to rapidly re-organize and even reconfigure themselves in order to capitalize on immediate, and perhaps only temporary, market opportunities (Gunasekaran, 1998). There are a variety of possible responses that a firm can make. These range from a complex, strategic move (like setting up a new venture), a simple move (like adjusting business rules within an existing venture) to no move (Ferrier *et al*., 1999). Response capabilities can be classified as pro-active response and re-active response.

Agility requires firms to modularize and re-engineer their existing processes and systems, to add something on top of the existing variety or to quickly (dis)connect to other partners, who can deliver specific capabilities. Agility requires responding to (unexpected) input or changing the input and processes in order to deliver the unexpected but desired output. The Law of Requisite Variety is important to analyze how firms can organize themselves to increase their response capability. This law originated in the field of cybernetics, control and systems theory. The Law of Requisite Variety is sometimes known as *Ashby's Law* after William Ashby who proposed it as follows "*the variety within a system must be at least as great as the environmental variety against which it is attempting to regulate itself*". This law has definite implications for businesses that want to be agile. Ashby's Law means that an agile system with many options is better able to cope with change. A system that is tightly optimized for an initial set of conditions might be more efficient whilst those conditions prevail but fail totally should conditions change. The more options the system has, the better it is able to deal with fluctuations. Variety of input can only be dealt with by variety of action. Companies need to be sufficiently adaptable to cope with business agility needs in a changing environment. A company that is too rigid faces potential danger if its market changes or even disappears. Take as an example the music industry, which has had great trouble adapting its business models to the internet. Those old models were excellent for the age of physical goods such as CDs but could not cope with the system perturbations introduced by downloaded digital music. The question is how much agility should be incorporated upfront in the design of a system (or organization). Adding extra agility is costly and can make systems complex. Take as an example SAP software. This software is capable of dealing with a wide variety of inputs, based on different parameters in the system. As a downside, due to the number of options available, it has become quite complex – at the cost of agility. Figure 2.2 illustrates how response range can be increased to respond to unexpected input or output requirements, based on the Law of Requisite Variety.

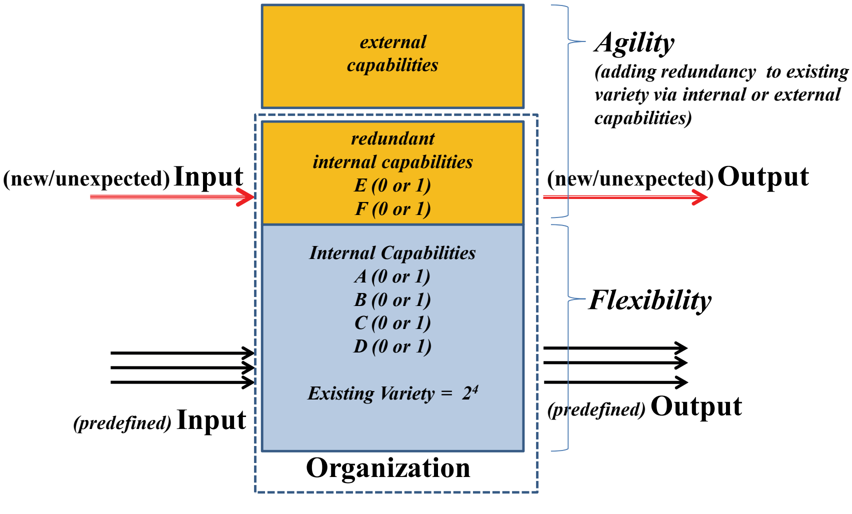

Figure 2.2 – Extending existing variety to manage unexpected input or output

Learning

Two interrelated practices - knowledge management and organizational learning - effectively leverage knowledge as an important capability of agile firms (Kidd, 2000; Dove, 2001; Jamali and Keshishian, 2006; Halal, 2006). Locke (1999) even suggests, that the competitive advantage of firms starts with the "constant discovery of new knowledge, followed by the constant communication and eventual computerization (i.e. codification) and utilization of this knowledge" (p. 8). Agile organizations capture learning from experiences and strategic experiments and apply it to future actions.

Knowledge management is defined as *the identification, acquisition, assimilation, diffusion, exploitation and renewal of all knowledge that the organization requires* (Dove, 1999, 2001; Zahra and George, 2002). In this context, *identification* addresses the dynamic nature of knowledge value, anticipating new needs in time to acquire knowledge and diffuse it. *Acquisition* refers to the fact that knowledge may be captured from internal resources, obtained from outside resources, or created by the organization. *Assimilation of knowledge* relates to data that is selected and transformed into information. Data becomes information when it is filtered for relevancy, timeliness, accuracy and content. *Diffusion* specifies that knowledge is understanding; and understanding only occurs when the information reaches people's heads at which point learning occurs. Organizational learning is *the continuous testing of experience, and the transformation of that experience into knowledge – accessible to the whole organization, and relevant to its core purpose* (Senge *et al*., 1994). Transformation of information into action requires meaningful tacit knowledge, which is a personal thing that resides in heads, not in databases. One of the key challenges in increasing agility is the degree in which tacit knowledge and ideas can be codified (i.e. transformed into effective and scalable action), so that others can understand, mobilize and take action when given an opportunity (Welborn *et al*., 2005). A distinction can be made between primary, market based learning and secondary, internal learning (Wheeler, 2002). Returning to the definition of knowledge management, *exploitation* relates to providing information to the right people at the right moment to helping them turn it into actionable knowledge. *Renewal* recognizes that knowledge value degrades with time and can become negative. The term *requires* assumes a timely evaluation of what knowledge is needed, when, and by whom to meet operational needs and strategic objectives (i.e. to remain agile). Organizations need to be aware of the factors that can hinder effective knowledge management. People who possess certain knowledge may be reluctant to share their knowledge with others for fear of losing ownership, giving up a position of privilege, relinquishing superiority, not being able to capitalize on incentives or even due to a lack of awareness regarding the fact that their knowledge might be of interest to others (van Baalen *et al*., 2005).

Firms basically can follow two knowledge management strategies, the codification strategy and the personalization strategy (Hansen *et al*., 1999). In the codification knowledge management strategy, knowledge is carefully codified and stored in databases (people-to-documents approach). There, it can be accessed and used easily by anyone in the company. This strategy is emphasized by companies that pursue an assemble-to-order or service strategy that reuses existing knowledge. In the personalization knowledge management strategy, knowledge is closely tied to the person who developed it through personal experience. In this strategy (tacit) knowledge is shared mainly through person-to-person contacts and IT is used to facilitate conversations and exchange of tacit knowledge (e.g. people-finder databases). This strategy is emphasized by companies that pursue highly customized service offerings or product innovation. Research of Hansen *et al*. (1999) shows that effective firms excel by focusing on one of the strategies while using the other in a supporting role.

Senge (1990) introduces the concept of the learning organization. He defines it as "*organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together*" (Senge, 1990:3). Senge argues that in situations of rapid change (i.e. high business agility need) only those organizations that are flexible, adaptive and productive will excel. This requires organizations to discover '*how to tap people's commitment and capacity to learn at all levels*' (Senge, 1990: 4). Senge identifies five disciplines at the foundation of learning organizations. The first discipline is systems thinking, which refers to seeing the organization as a dynamic process. The systems viewpoint is generally focused on a long-term view, which underlines the importance of delays and feedback loops. The second discipline refers to personal mastery, which is defined as "*the discipline of continually clarifying and deepening our personal vision, of focusing our energies, of developing patience, and of seeing reality objectively*" (Senge, 1990: 7). People with a high level of personal mastery live in a continual learning mode The third discipline refers to mental models, which are defined as "*deeply ingrained assumptions, generalizations, or even pictures and images that influence how we understand the world and how we take action*" (Senge, 1990: 8). Existing mental models include cloud sensing, responding and learning. The fourth discipline refers to building a shared vision. Such a vision has the power to be uplifting – and to encourage experimentation and innovation. When there is a genuine vision people excel and learn, not because they are told to, but because they want to. Finally, the fifth discipline of learning organizations is team learning. This is viewed as "*the process of aligning and developing the capacities of a team to create the results its members truly desire*" (Senge, 1990: 236). It builds on personal mastery and shared vision.

When teams learn together, Senge suggests, not only can there be good results for the organization, but members will grow more rapidly than could have occurred otherwise.

Based on this previous work and definitions on knowledge management and organizational learning (Senge, 1990; Senge *et al*., 1994; Dove, 1999, 2001; Zahra and George, 2002; Bhatt and Groover, 2005) we define learning capability as an enhancer or even multiplier for business agility:

> Learning is *the ability of an organization to explore and acquire new and relevant knowledge, to assimilate data and experience into information and to exploit, use and renew knowledge when required, in order to enhance sensing and responding.*

Table 2.3 describes how business agility differs from flexibility by comparing the two concepts on the three sub dimension sensing, responding and learning.

Table 2.3 – Comparing flexibility with business agility

(Sub)dimension	Flexibility	Business Agility
Sensing (what)	Uncertain event (opportunity or threat), low to medium rate of change	Uncertain event (opportunity or threat) High rate of change
Sensing (when)	Anticipated (predictable)	Unanticipated (unpredictable)
Sensing (for what reason)	To anticipate or detect opportunities or threats within a predefined range referring to the input or output of the organization.	To anticipate or detect unanticipated opportunities or threats beyond a predefined range referring to the input or output of the organization
Sensing (how)	Based on internal capabilities	Based on internal, customer and partnering capabilities
Response (what)	Variety of response strategies comes from existing set of resources with a <u>predefined range</u> of response options	Variety of response strategies is not in the existing response range, but still needs to be delivered. This requires an increase of response range via adaptation, building or acquiring (via external partners) new systems and/or competences
Response (how)	<u>Predefined</u> response based on internal capabilities	<u>Innovative</u> response based on internal and external capabilities (partners and customers)

(Sub)dimension	Flexibility	Business Agility
Response (when)	Predefined response time window	Redefinition of response time window (i.e. reduction of cycle time)
Learn (how)	Internal learning (individual and team learning)	Internal learning (individual and team learning) and external market based learning (e.g. via communities of practice and via crowd sourcing)

Relationship among sensing, responding and learning

The relationship between the sensing, responding and learning capabilities builds upon the concept of Observe, Orient, Decide and Act (OODA) loops (Carlsson and Sawy, 2008). The concept of OODA loops was originated by US Air Force colonel John Boyd who wanted to understand how fighter pilots won air combat engagements (dogfights) against other pilots despite flying aircraft with inferior maneuverability. Boyd found that winning pilots were able to compress the entire cycle of activities that happen in a dogfight and complete them more quickly than their adversaries. Boyd's OODA loop of activities is comprised of: observation (seeing the situation and adversary), orientation (sizing up vulnerabilities and opportunities), decision (deciding which combat maneuver to take), and action (executing the maneuver). The organization that can complete its OODA loops quickly when changes occur in business processes and in the environment is in a much better position to survive. Haeckel (1999) later extended this concept. In his book Adaptive Enterprise: creating and Leading Sense-and-Respond Organizations Haeckel (1999) set out the transition of organizations from a make-and-sell business design to a sense-and-respond business design. IBM used these concepts to build their sense-and-respond organizational framework (Mitchell *et al*., 2003). The relationship between sensing (S), responding (R), enhanced by learning (L) capabilities can be described as a beneficial SRL-cycle, which is shown in Figure 2.3.

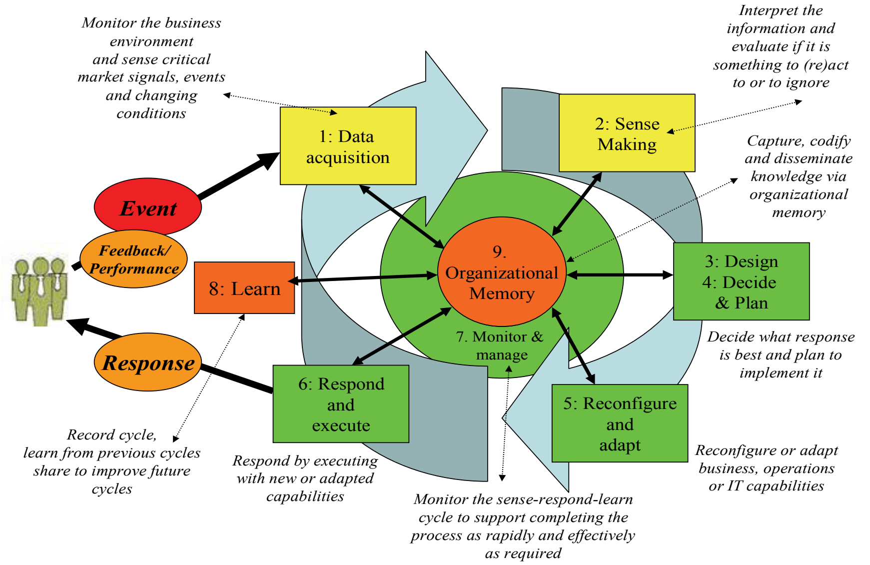

Figure 2.3 - Sense-Respond-Learn Cycle (adapted from Mitchell *et al.*, 2003: 7)

2.2.5 How to be agile: internal versus external agility

Sensing, responding and learning capabilities can be sourced internally within the organization or externally via partner organizations or customers. Depending on the business agility performance levels within the individual capabilities and the business agility need, firms need to find a balance between internal and external agility. Internal agility is defined as "*the ability to change and reconfigure the internal parts of the enterprise - strategies, organization, technologies, and even people in response to change, unpredictable events and uncertainty in the business environment*" (Kidd, 2000). External agility is defined as "*the ability to change and reconfigure the external parts of the enterprise - partners, suppliers, distributors, and even customers in response to change, unpredictable events and uncertainty in the business environment*" (Kidd, 2000). Sambamurthy *et al*. (2003) classify external agility into customer agility and partnering agility, while they use the concept of operational agility to describe internal agility. This distinction is in line with types of strategic agility defined by Weill *et al*. (2002), who distinguish between business initiatives aimed at increasing strategic agility based on their position in the value net: demand-side initiatives (customer agility), supply side initiatives (partnering agility) and internal focused initiatives (operational agility). Sambamurthy *et al*. (2003) argue that firms that have developed all of the three sourcing strategies for agility are in a better position to engage in more competitive action by bundling their customer, partnering, and operational agility.

Operational agility is defined as *the ability to accomplish speed, accuracy, and cost economy in the exploitation of innovation opportunities* (Sambamurthy *et al*., 2003). World class excellence of internal capabilities can be achieved via continuous improvement methods for capability enhancement (i.e. Six Sigma) and investment in enabling information infrastructures and services platforms (Sambamurthy and Zmud, 2004). Operational agility builds upon three other generations of corporate transformations (Sambamurthy and Zmud, 2004): Total Quality Management (TQM), lean management (incl. mass customization and Six Sigma) and organizational adaptiveness. Each wave of corporate transformation emphasizes specific types of capabilities and performance enhancement. In Appendix A a comparison is included. This comparison makes clear that firms that are organized according to a generation of corporate transformation that precedes 'business agility' are faced with organizational processes, culture and IT that is out of alignment with the fundamental concepts of business agility – sensing, responding and learning. This can explain the lack of business agility performance. Sambamurthy and Zmud (2004) claim that organizations should progress through these different phases of transformation as part of a learning process. This implies that if companies need to migrate from previous generations of corporate transformation to business agility, then they should especially invest in learning capabilities.

On the partnering side, organizations can achieve agility through the creation and management of partnerships in a resourceful and competent manner. Sambamurthy *et al*. (2003) use the term partnering agility, which they define as *the ability to leverage assets, knowledge, and competences of suppliers, distributors, contract manufacturers and logistics providers in the exploration and exploitation of innovation opportunities*. (Sambamurthy *et al*. 2003). Partnering agility builds on established practices in supply chain management and supply chain agility (Christopher and Towill, 2000; Van-Hoek *et al*., 2001; Yusuf *et al*., 2004) and smart business networks (Vervest *et al*., 2005).

Customer agility is defined as *the ability to co-opt customers in exploration and exploitation of innovation opportunities as sources of innovation, co-creators of innovation and as users in testing ideas or helping other users learn about the idea* (Sambamurthy *et al*., 2003). Customer agility describes a firm's ability to leverage the voice of the customer in gaining market intelligence and detecting competitive action opportunities. An example of a customer agility strategy is the usage of web-based self-service environments, where customers are offered personalized products and services based on real-time product configurations and historic databases that match profiles to offers (like Amazon). Available, complete, pertinent, and easy-to-access information on customers' needs, anxieties, and service requirements via IT is a key enabler for business agility (Christopher, 1992).

2.2.6 How to be agile: framework of dynamic capabilities

Combining the perspectives of Sambamurthy *et al*. (2003) with Dove (2001) leads to a 3x3 matrix with dynamic capabilities, which characterizes agile firms. Figure 2.4 provides this matrix with three dimensions of business agility on the horizontal axis and three ways of sourcing different dynamic capabilities on the vertical axis. For some cells we have included an example to illustrate how such capabilities can be implemented in practice. We now discuss the different dynamic capabilities.

		Dimensions of Agility		
		Sense	Respond	Learn
Sourcing	Operational (internal)	Data acquisition Sense-making	Response design Response decison making Response implementation Quick-connect Response monitoring	Organizational Memory Information Dissemination Internal Learning
	Customer	Customer data acquisition *e.g. experimenting new technologies with customers, customer feedback*	Customer Response design Customer response implementation *e..g via self-service environments*	Customer (market based) Learning, *e.g. via survey feedback of customers*
	Partnering	Partnering data acquisition *e..g. Point of Sale data of partners*	Partnering response design Partnering response implementation *e..g via self-service environments*	Partnering (market based) Learning

Figure 2.4 - Dynamic capabilities framework for business agility

Sensing consists of data acquisition and sense-making. *Data acquisition* is the ability of firms to actively seek out and gather useable information (adapted from Kohli and Jaworski, 1990). Three sources for such information can be distinguished: information from direct experience (e.g. process data, market research data), information based on experience of others (e.g. from customers) and information from internal organizational memory (such as data mining on internal organizational memory). *Sense-making* is the ability to assimilate data into information (by filtering it for relevancy, timeliness, accuracy and content), interpret the information, and analyze the urgency, causes and impact of the event. Responding is divided into five separate capabilities. *Response design* is the ability to generate possible responses and experiment with these responses. *Decision-making* relates to the ability to decide on a specific response. *Response implementation* is the ability to (re)configure or adapt business, operations or IT capabilities and respond with new or adapted capabilities. *Quick-connect* is the capability to quickly establish an inter-organizational tie that facilitates the exchange of information and transactions, and facilitates quickly disconnecting and quickly handling complexity with new business partners (Koppius and van de Laak, 2008). *Response monitoring* is the ability to monitor the execution of the SRL-cycle and the impact (effects of response) on performance. Three learning capabilities are distinguished. *Organizational memory* is the amount of stored information or experience a firm has about a particular phenomenon (Moorman and Miner, 1997: 103). A distinction can be made between declarative memory (knowledge of facts and events) and procedural memory (knowledge about routines, processes and procedures) (Moorman and Miner, 1998). *Information dissemination* is the extent to which the information that is obtained by a firm is shared between its functional units through formal and informal channels (Maltz and Kohli, 1996). Finally, *learning feedback* is defined as the ability to analyze and reflect on the SRL-cycle and its impact as compared with previous SRL-cycles. This, in turn, generates feedback to reconfigure or adapt sensing or responding capabilities. Depending on the type of event, the level of uncertainty, the required response level (operational, tactical or strategic) and the sourcing strategy with regards to agility (operational, customer and/or partnering agility), specific capabilities will exhibit varying degrees of importance in relation to business agility performance.

2.2.7 Means for business agility

Business agility means are *the means (i.e. enablers) for an organization to enhance business agility*. Different researchers have analyzed the means for enhancing the agility of organizations, supply chains and even business networks. Based on a literature study we came up with a list (see Table 2.4) of seven domains of possible strategies for enhancing business agility. This list is not meant to be exhaustive, but does provide an impression of the wider scope and attention the topic of business agility has generated in the literature. The first domain is *network governance*, which refers to ‘interfirm coordination that is characterized by organic or informal social systems, in contrast to bureaucratic structures within firms and formal contractual relationships between them’ (Nohria and Eccles, 1993). *Network architecture* refers to the structure of the network that enables a firm to leverage the strengths and competences of network partners and easily restructure to facilitate business agility need. *Organizational governance* refers to the command and control structure of the organization that supports communication and decision making to cope with business agility need. *Organizational or enterprise architecture* is ‘the organizing logic for core business processes and IT infrastructure reflecting the standardization and integration of a company’s operating model’ (Ross *et al*., 2006).

Table 2.4 – Means for enhancing business agility

Business Agility Means Type	Business agility means and characteristics found in literature	References
Network governance (M1)	Relationships based on Trust	(Preiss *et al*., 1996), (Christopher and Towill, 2000), (Power *et al*., 2001), (Van-Hoek *et al*., 2001), (Handfield and Bechtel, 2002)
	Performance metrics, measurement and benchmarking	(Goldman *et al*., 1995), (Meredith and Francis, 2000), (Sambamurthy *et al*., 2003), (Christopher *et al*., 2004), (Lin *et al*., 2006)
	Process integration and collaborative work (such as joint product development, co-managed inventories and collaborative planning and joint strategy determination).	(Sharifi and Zhang, 1999), (Christopher, 2000), (Christopher and Towill, 2000), (Power *et al*., 2001), (Bruce *et al*., 2004), (Van Oyen *et al*., 2001), (Christopher *et al*., 2004)
	Virtual organization structure (other terms used are *extended enterprise* or *value nets)*	(Goldman *et al*., 1991), (Byrne, 1993), (Shariffi and Zhang, 1999), (Christopher and Towill, 2001)
Network architecture (M2)	Loosely coupled	(Konsynski and Tinana, 2004)
	Modularization	(Konsynski and Tinana, 2004)
	Information sharing and visibility	(Towill, 1996), (Mason-Jones, 2000), (Van Hoek, 2000), (Christopher, 2000), (Christopher and Towill, 2000)
	Heterogeneity retention (using variety and complementarities of expertise)	(Konsynski and Tinana, 2004)
Organizational governance (M3)	Reward systems that support business agility and are competency-based	(Preiss *et al*., 1996), (Crocitto and Youssef ,2003)
	Incentives for collaborative learning and sharing of work practices	(Nadler and Tushman, 1997)
	Self organization (create new structural options out of existing resources)	(Conner, 2000)
	Virtual cross functional project teams (within and across organizations)	(Goldman *et al*., 1991), (Kidd, 1995), (Breu *et al*., 2002)
	Employee empowerment and autonomy in decision making	(Katzenbach and Smith, 1992), (Goldman and Nagel, 1993), (Gehani, 1995), (Nadler and Tushman, 1997), (Shariffi and Zhang, 1999), (Yussuf *et al*.,1999), (Van Oyen *et al*., 2001)
	Performance metrics and evaluation	(Goldman *et al*., 1995)
	Flexible budgeting procedures	(Goldman *et al*., 1995)
Organizational	Standardization and simplification (of	(Kidd, 1995), (Kidd, 2000), (Dove,

Business Agility Means Type	Business agility means and characteristics found in literature	References
architecture (M4)	processes and components)	2001)
	Modularity (plug and play of business capabilities, products and services)	(Kidd, 1995), (Kidd, 2000), (Dove, 2001)
	Flexible and reconfigurable organizational structure (processes, products and services)	(Goldman *et al*., 1995), (Kidd, 1995), (Kidd, 2000), (Preiss *et al*., 1996), (Dove, 2001)
	Customization (of products and services)	(Christopher,1992), (Preiss *et al*., 1995)
	Quick-connect capability	(Gunasekaran, 1998), (Sanchez, 1995), (Goldman *et al*., 1995), (Van Heck and Vervest, 2007), (Koppius and van de Laak, 2008)
IT capabilities (M5)	Standardization and (architected) simplification	(Duncan, 1995), (Byrd and Turner, 2000), (Ross, 2003), (Konsynski and Tinana, 2004)
	Connectivity	
	Compatibility	
	Modularity	
	Scalability	(Knoll and Jarvenpaa, 1994), (Dove, 2001)
	Reconfigurability	
	Data quality and data access	(Christopher, 2000), (Christopher and Towill, 2000), (McCoy and Plummer, 2006)
	Extended enterprise integration	(Goldman *et al*., 1995)
People capabilities (M6)	Knowledge (tacit), skills variety and redeployability	(Katz, 1974), (Gunasekaran, 1999), (Lui and Piccoli, 2006)
	Speed of acquiring and developing new skills (dynamic specialization)	(Breu *et al*., 2002)
	Internal bonding social capital and external bridging social capital	(Huysman and Wulf, 2004), (Newell *et al*., 2004)
Organizational Culture (M7)	Fostering individual entrepreneurship	(Goldman and Nagel, 1993), (Preiss *et al*., 1996)
	Leadership (leading by coaching)	(Shani *et al*., 1992), (Preiss *et al*., 1996), (Crocitto and Youssef, 2003)
	Fostering a culture of knowledge sharing and learning (e.g. via communities of practice)	(Goldman *et al*., 1995), (Katzenbach and Smith, 1992), (Breu *et al*., 2002)

IT capabilities refers to IT capabilities and IT architecture that enable business agility. *People capabilities* refer to the variety of skill levels of people to handle business agility needs. Finally, *organizational culture* refers to ‘the specific collection of values and norms that are shared by people and groups in an organization and that control the way they interact with each other and with stakeholders outside the organization' (Hill and Jones, 2001). Dove (2005) stresses the importance of organizational culture and mindset. *Agility can't be bought in a box—it must be actively practiced as a mindset in the organization* (Dove, 2005). A thinking and learning environment can be created by rewarding innovations and accepting failures. To sense and respond rapidly to opportunities and threats, companies need a nurturing environment where employees feel empowered to act (Street *et al*., 2003). Organizations can achieve higher levels of business agility and increase their business agility performance if they use these business agility strategies in the design and management of their organization and business network. This dissertation will focus on how IT capabilities (M5) can be used as a means to enhance business agility and the factors that influence this approach.

2.2.8 Business agility performance and gaps

> Business agility performance is *the performance of an organization in swiftly changing businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events*.

Business agility performance is a multi-dimensional concept that can be assessed in terms of four change proficiency metrics (Dove, 1995; Dove, 2001): *(i) response time* (the time needed to execute decision making and change operational cycles i.e. lead time), *(ii) response cost* (the costs needed to execute decision making and change operational cycles), *(iii) response quality or robustness* (on time, on budget, on specifications) and *(iv) response range* (the magnitude of change which can be accommodated (variety)). The level of business agility performance is not an absolute and static state. Most firms will have a business infrastructure, where some parts are very agile, while other parts lack agility. In many cases that is not really a problem; it is more or less an outcome of industry dynamics. Organizations have a business agility gap when the level of business agility performance required to respond to an uncertain event (i.e. business agility need) does not match with the available level of business agility performance. A business agility gap can be either a lack of business agility performance or a surplus.

> Business agility gap is *the mismatch between the businesses agility need and the business agility performance*.

Business agility gaps arise when the organization either has difficulty in meeting the required level of agility (for a specific event) in changing from one state to another in a timely and cost effective manner, or when there is a surplus of business agility performance. The existence of a business agility gap is always relative in time and place in relation to competing firms.

2.3 Information Technology Agility

2.3.1 What is IT agility?

As discussed in section 2.2.7 many elements contribute as a means to enable business agility. Many scholars preach the enabling role of IT capabilities to enhance business agility (for example Goranson, 2000; Haeckel, 1999; Sambamurthy *et al*., 2003; Moitra and Ganesh, 2005). The common idea is an agile responsive organization that can (re)configure its resources and people quickly and which is flexible enough to sense and respond to changing demands, enabled by IS in general and Internet-based IT infrastructure in particular (Umar, 2005; Pearlson and Saunders, 2006). In other words, agility of information technology (IT agility) enables business agility (Byrd and Turner, 2001; Sambamurthy *et al*., 2003; Overby *et al*., 2006; Lee *et al*., 2007). But how can we define IT agility? And which capabilities determine the level of IT agility? Table 2.5 provides an overview of definitions related to IT agility in literature.

Table 2.5 - Definitions on IT agility

Term	Definition	Reference
IT infrastructure flexibility	The ability to easily and readily diffuse or support a wide variety of hardware, software, communications technologies, data, core applications, skills and competences, commitments, and values within the technical physical base and the human component of the existing IT infrastructure.	(Byrd and Turner, 2000)
IT agility	The ability to build a system that can easily be reconfigured, scaled, deconstructed and reconstructed as needed, to adapt to unanticipated changes.	(Ahsan and Ye-Ngo, 2006)
Agile information system	… enables the firm to identify needed changes in the information processing functionalities required to succeed in the new environment, and which lends itself to the quick and efficient implementation of the needed changes.	(Lui and Piccoli, 2006)
IT agility	Reconfiguring or replacing your information technology systems when new marketplace realities change the way you have to do business.	(Sengupta and Masini, 2008)

Most of previous IS literature on IT agility explored the agility of the IT infrastructure (e.g. Nelson and Cooprider, 2001; Weill *et al*., 2002; Ahsan and Ye-Ngo, 2006), based on connectivity, compatibility, modularity and capability characteristics. Another stream of literature explored (methods for) agile software development (e.g. Abrahamsson *et al*., 2002; Nerur *et al*., 2005). Nelson *et al*. (1997) and Byrd and Turner (2000) included a systems component and a human component of IT agility. Organizations seeking agility through technology need to consider technology in a broader context as a system containing the technology application, the people that maintain and support the application, and the management processes that these people use to accomplish their work. Upton (1994) points out that many of the disappointments with emerging technologies may be a result of a failure to consider the people side of IT agility. We discuss the people side in more detail in section 2.4. Based on this literature driven conceptualization of business agility, we define IT agility as:

Information Technology agility is *the ability of Information Technology to support an organization to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events*. In order for Information Technology to be agile it needs to support and align the three dimensions of business agility -- sensing, responding and learning.

2.3.2 Enterprise architecture perspective

The enterprise architecture perspective is used to analyze agility of IT in more detail. There are various definitions of enterprise architecture in the literature. Often, architecture and infrastructure are used interchangeably, where architecture can be seen as the plan for the next infrastructure. The Open Group[1] has defined architecture as '*a formal description of a system, or a detailed plan of the system at component level to guide its implementation. It is the structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time'* (Open group). Ross *et al*. (2006) define enterprise architecture as "*the organizing logic for core business processes and IT infrastructure reflecting the standardization and integration of a company's operating model*". Enterprise architecture basically consists of four layers (Open Group; Ross *et al*., 2006): business architecture, application architecture, data architecture and technology (or ICT platform) architecture. *Enterprise* architecture is not a concrete set and must constantly be reviewed. In most firms, it provides the (technical) guidelines rather than the rules for decision-making. The enterprise architecture (EA) has to cope with business uncertainty and technological change. The enterprise or IT architecture *forms the core set*

[1] http://www.opengroup.org/architecture/togaf8-doc/arch/

of policies and rules that direct and govern the use of IT and plot a migration path to the way business will be done in the future. A key objective of using enterprise architecture standards is to control the growth of technical diversity in an enterprise, given that the rapid adoption of state-of-the-art IT products can easily lead to incompatible IT products (Hite, 2003).

Agility can be incorporated in each layer of the enterprise architecture of an organization and in the enterprise architecture as a whole. The core challenge for achieving (IT) agility is to achieve alignment among sensing, responding and learning and to achieve alignment across the different layers and components of the enterprise architecture to drive executional consistency (Welborn *et al.*, 2005). Sensing, responding and learning capabilities can be sourced internally within the organization or externally via partner organizations or customers. This distinction between internal agility and external agility is also shown in Figure 2.5. In the remainder of this section, IT agility is analyzed from a structural design-perspective within the enterprise architecture as a whole and in the various layers of the enterprise architecture. This is shown in Figure 2.5.

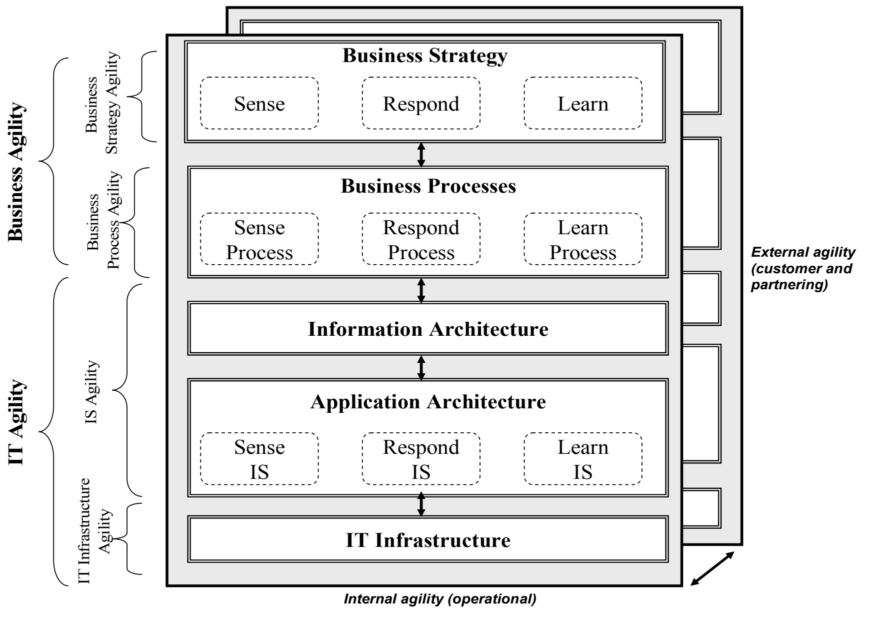

Figure 2.5 - Agility in various layers of the Enterprise Architecture

A good architecture evolves over time, is documented, and is accessible to all managers in the firm (Buuron, 2002). Complex and large organizations have multiple architectures, which can be in different stages of maturity. More traditional architectures are used in stable environments, where performance and stability is favored over flexibility. Aerts *et al*. (2004) provide an outline of the historical development of IT from an architectural layer perspective. On the business layer the focus has moved from functional hierarchy (50s-70s) to the organization/business process (80s), supply chain (90s) and business network (today). On the application layer the focus has moved from functions (50s-70s) to enterprise wide applications (90s) to services (today). On the information layer the focus has moved from centralized data (50s-80s) to shared data (90s) to distributed data (today). On the IT infrastructure layer the focus has moved from mainframe computing (60s-70s) to client server architectures (80s) to ubiquitous computing with multi-site service oriented architectures (today).

Enterprise architectures often mirror historical decisions (such as choice of organizational structure, product-market combinations) and the historical development of the organization (such as previous consolidations, mergers and acquisitions). This results in complex and different technical environments with different levels of IT architecture maturity. As a result, IS/IT can have various sometimes conflicting effects on an organization's level of business agility. In a study by Ekman and Angwin (2007), among 146 IT users in Europe, they found a large spread in IS/IT leverage among the four agility dimensions of Goldman *et al*. (1995), ranging from relative low scores for leveraging of (internal) resources to relatively high scores for enriching customers. This spread characterizes the banking industry, where internet banking allows customers to access bank services 24/7, while at the same time many banks still operate inflexible backend production systems with poor resource utilization and limited supply-chain integration.

Simultaneous achievement of flexibility and efficiency are two vital elements for IT architectures to deal with agility requirements (Allen and Boynton, 1991). Organizations have used two architectural solutions for achieving both objectives, ranging from highly decentralized to highly centralized. A highly decentralized approach has hardly any central IS organization. It relies on full access to information and data-exchange conventions for linking local systems. On the other hand, a highly centralized approach centralizes common business practices and application systems, data collections and IT platforms. Both approaches have their pros and cons. Allen and Boynton (1991) suggest organizations should combine elements of both approaches.

Based on four studies regarding 180 successful business initiatives Weill *et al*. (2002) identified specific infrastructure capabilities needed for different electronically based business initiatives (internal, supply side and demand side). They argue that the time required to implement a new business initiative significantly depends on the enterprise's infrastructure capability. Investing in IT infrastructure could be compared with buying an option. If exercised, infrastructure enables faster time to market (i.e. more agility), however if underused it results in higher costs with inadequate returns. The greatest challenge therefore is the governance of the infrastructure: the management process used to implement the best mix of infrastructure capabilities at the right level (centralized or local) at the right moment to suit a specific enterprise.

Research shows that a firm's IT architecture is a major business resource and a key source for attaining long-term competitive advantage (Keen, 1991; Weill and Broadbent, 1998; Venkatraman, 1994; Davenport and Linder, 1994). Enterprise IT architecture maturity defines how IT attributes are connected (visibility and traceability), the degree in which IT has been standardized, the degree in which processes have been standardized and connected and the degree in which data is shared. Ross *et al*. (2006) distinguished four stages of (increasing) IT architecture maturity; Business Silos, Standardized Technology, Optimized Core, Business Modularity. Each stage of IT architecture maturity has its own characteristics (Table 2.6).

Ross (2003) described the four stages of the enterprise IT architecture and used this as a guideline to determine the enterprise IT architecture maturity of the forty case sites she studied. From this classification, it appeared that seventy-five percent of the researched firms are in the first two phases and none in the fourth phase. In 2005, over eighty percent of the organizations were in the second and third phase and only five percent in the fourth phase. Ross *et al*. (2006) emphasized the process of maturing through the phases since it will improve organizational performance. The fourth phase, in particular, leads to a variety of benefits for the organization: improved IT responsiveness, risk management, managerial satisfaction and strategic business impact. The type of strategic business impact depends on the business strategy chosen (operational excellence, customer intimacy, product leadership and strategic agility). To profit fully from the enterprise architecture, organizations need to rethink how their business will be conducted. First the operating model should be made explicit, after which the facilitating enterprise architecture can be designed, in order to align IT with the business.

The transition from one stage of IT architecture maturity to another requires major organizational transitions. It is unfeasible to skip any stage, since more mature stages build on previous stages. Generating value from investments in architecture is a learning process. Learning should be captured in management and governance practices. Requirements from management are more complex in later stages. The research of Ross *et al*. (2006) also found that firms who gain strategic business benefits from their architecture investments have senior business leaders who are actively involved in architecture design, management, and implementation.

Table 2.6 - Learning requirements of the architecture stages (source:Ross *et al*., 2006)

	Business Silos	Standardized Technology	Optimized Core	Business Modularity
IT capability	Local IT applications	Shared technical platforms	Companywide standardized processes or data	Plug-and-play business process modules
Business objectives	ROI of local business initiatives	Reduced IT costs	Cost and quality of business operations	Speed to market; strategic agility
Funding priorities	Individual applications	Shared infrastructure services	Enterprise applications	Reusable business process components
Key management capability	Technology-enabled change management	Design and update of standards; funding shared services	Core enterprise process definition and measurement	Management of reusable business processes
Who defines applications	Local business leaders	IT and business unit leaders	Senior management and process leaders	IT, business, and industry leaders
Key IT governance issues	Measuring and communicating value	Establishing local/regional/ global responsibilities	Aligning project priorities with architecture objectives	Defining, sourcing, and funding business modules
Strategic implications	Local/ functional optimization	IT efficiency	Business operational efficiency	Strategic agility

2.3.3 Agility of Information Systems

An agile information system can be defined as '*an information system that enables the firm to identify needed changes in the information processing functionalities required to succeed in the new environment, and which lends itself to the quick and efficient implementation of the needed changes'* (Lui and Piccoli, 2006: 123). Agility on the information systems layer applies when changes in information systems are required, due to (external) agility requirements from business.

Previous researchers analyzed the dilemma of information systems designers regarding the amount of flexibility or agility to build into an information system upfront, given the cost and development effort required to do so (Land, 1982). Mårtensson and Steneskog (1996) discuss a trade-off in the (upfront) incorporation of agility in the design of information systems. They distinguish three levels of agility for information systems with decreasing levels of upfront agility included. Versatility refers to whether the existing variety included in an information system is flexible enough to cope with changing conditions. Reconfigurability of an information system refers to "pent-up" or potential agility that can be released via a new configuration by changing a number of parameters. Finally, (re)construction of an information system may be required to develop new functionality. Mårtensson (2006) argues that using versatility to cope with changing conditions and uncertain events is more agile than having to use reconfiguration, which in turn is more agile than having to resort to reconstruction. This is illustrated in Figure 2.6. The agility performance of an information system is determined by the response time (time agility), response range (range agility), response quality and (resulting) response cost to have a new or modified information system in place, which supports (the response to) a new business need.

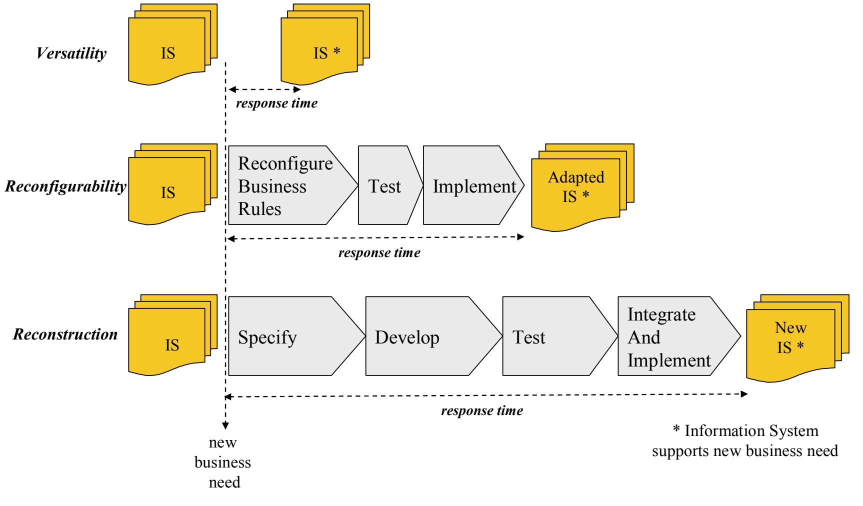

Figure 2.6 - Time agility of Information Systems

The IT industry has come up with various approaches to incorporate structural IT agility in Information Systems (design). The most widely used type of IS are Enterprise Resource

Planning (ERP) software packages, which merge a firm's data, information flows and business processes into a single package. ERP systems contain a certain level of versatility and reconfigurability to deal with agility requirements. Often this includes internal processes and processes in relation to suppliers, partners and customers. Research of Lengnick-Hall *et al*. (2004) shows that *even if ERP is necessary to coordinate complicated, multifaceted operations, it is far from sufficient to promote a strong competitive position over the long term*. Information in ERP systems is processed according to prescribed algorithms that are intentionally predictable, and repetitive. ERP systems have operational and structural flexibility embedded to accommodate the occurrence of a predictable change. Therefore, ERP systems fit best within mechanistic, clockwork organizations dominated by routine, highly programmed technologies and operations.

The introduction of massive ERP systems simultaneously introduced new levels of complexity (thousands of installation options and countless interrelated pieces), often without fully eliminating the older legacy systems (Rettig, 2007). Different divisions or facilities often made independent purchases of ERP systems, and other systems were inherited through mergers and acquisitions. Thus, many companies ended up having several instances of the same ERP system or a variety of different ERP systems altogether, further complicating their IT landscape. In the end, ERP systems became just another subset of the legacy systems they were supposed to replace (Rettig, 2007). Customization made changing the software later — or upgrading to a newer version — far more difficult, and in some cases prohibitively expensive. Reengineering is responsible for about 43% of the costs for implementation of a new ERP package. Also, integration of data is a well-known problem in the implementation of ERP systems. Differing formats, conventions, abbreviations and so on make data integration a challenging activity. Data conversion makes up about 15% of the implementation costs of new ERP software (Rettig, 2007).

ERP information systems tend to create organizations with similar business processes. Nicholas Carr (2004) pointed out in his book, "*Does IT Matter? Information Technology and the Corrosion of Competitive Advantage*," that simply implementing the 'plain-vanilla' business processes that your competitors have does not provide any competitive advantage. However, it is the non-routine learning, exploiting distinctive tacit knowledge and change processes, found in complex, self-organizing systems that enable firms to create distinctive competitive advantages (Hitt *et al*., 2000). ERP does not provide a competitive advantage on its own, but ERP does provide a platform for increasing social capital and intellectual capital, which are sources of competitive advantage for firms competing in the knowledge economy (Lengnick-Hall *et al*., 2004). The key challenge in achieving agility and sustainable competitive advantage from ERP is related to how well the respond capabilities of ERP are integrated with the organization's culture -- its sensing, responding, and learning capabilities.

2.3.4 Information architecture and data quality

An important element in the enterprise IT architecture is the information architecture, which can be defined as "*a personnel, organization, and technology independent profile of the major information categories used within an organization. It provides a way to map information needs, relate them to specific business functions, and document their interrelationships. It is used to guide applications development and facilitate integration and sharing of data*" (Brancheau *et al*., 1989). An important aspect of information architecture is the quality of the data. One of the dimensions of data quality is accessibility of data (Strong *et al*., 1997) and sharing of data. If high quality data is accessible and shared within and between organizations, this provides an important enabler for agile organizations and agile supply chains (Christopher, 2000; Christopher and Towill, 2000; Kumar *et al*., 2007). This visibility of data - which can be discussed in terms of information quality- can be a key enabler or inhibitor to business agility (McCoy and Plummer, 2006). The Internet, in particular, provides an important channel for sharing data, information and knowledge (McGaughey, 1999; Yusuf *et al*., 2004; Christopher, 2000). Sensing capabilities can be improved by more timely and accurate internal and external data (sharing). Also, high quality data provides the basis for actionable knowledge, which is required for response capabilities. Finally, first and second order learning require availability of high quality data.

Using high quality information not only enables business agility, but also serves as an important component in the U.S. Defense Department modernization strategies for warfare. Real-time information superiority is the new focus in *Network Centric Warfare*, which is the military response to the opportunities created by the Information Age. Empirical evidence supports a strong correlation between information (sharing) quality, improved situational awareness and significantly increased combat power (survivability, lethality, speed, timeliness, and responsiveness) (Alberts and Garstka, 2001).

Low data quality can have different manifestations, such as incompleteness of data, the usage of inconsistent data formats and semantics, insufficient or untimely access to data etcetera. Barriers to data access can be a lack of computing resources, privacy and confidentiality problems and computerizing and data analyzing problems, due to problems with interpretability, a lack of concise and consistent representation, timeless and amount of data (Strong *et al*., 1997).

Since high quality data feeds sensing, responding and learning capabilities; a low quality of data will have negative effects on the business agility performance of organizations. Based on a study among CIOs and IS users in 120 companies Chang and King (2005) found a positive correlation between IT systems performance (including quality, responsiveness and flexibility), data effectiveness (including data quality, data accessibility and data flexibility) and service performance (including responsiveness and flexibility). In a study among 329 manufacturing firms in Malaysia, Zain *et al*. (2005) found information quality and IT systems use had a strong positive effect on organizational agility. Information quality depends on how the information is perceived and used by users and customers.

2.3.5 How IT capabilities support sensing, responding and learning

The effective use of IT is an important method for firms to initiate and sustain the beneficial cycle of sensing, responding and learning. Figure 2.7 summarizes the main information technologies supporting and enabling the different business agility dimensions. A relevant distinction is IT that generates or exploits structured data versus IT that is based on unstructured data. This reflects two worlds in the IT industry, which increasingly become interlinked: the world of structured data and enterprise systems and the world of internet and web (2.0/3.0) applications.

Business Agility Dimensions

Typology of IT	**Sensing**	**Responding**	**Learning**
IT for structured data	<u>Data Acquisition</u> Operational Data capture (point-of-sale / barcodes/RFID) Web Tools for Customer Inclusion (e.g. product design) <u>Sense-Making</u> Business Intelligence Data-mining Decision Support Systems Business Activity Monitoring	<u>Process Reach</u> BPM tools, Groupware Collaborative & SCM platforms ERP & CRM systems Self-Service (web)environments Middleware tools, Agent Technology IT infrastructure virtualization tools <u>Process richness</u> Decision Support Systems Tracking technologies (RFID) <u>Response Performance Monitoring</u> Information dashboards Business Activity Monitoring tools	<u>Organizational memory</u> Intranets and databases Knowledge repositories Web-spaces <u>Learning from past transactions</u> Business Intelligence Data-mining Tools for machine learning and bayesian networks Social network analysis tools <u>Learning feedback tools</u> Survey tools
IT for unstructured data	Communities Blogs Wiki's Discussion Fora	Presence & Communication tools Video-conferencing Instant messaging	<u>Information dissemination</u> video-conferencing systems <u>Collaborative (learning) tools:</u> Wikis/blogs Discussion Fora Crowd-Sourcing tools

Figure 2.7 – Information technologies supporting business agility dimensions

How IT supports sensing

Examples of IT capabilities which can enable sensing are technologies for building and enhancing virtual customer communities for product design, feedback, and testing (Sambamurthy *et al*., 2003). Recent advances in web 2.0 technology, such as communities, wikis and blogs, make it possible to involve customers as 'prosumers' in product innovation (via on-line product configurators) and sense changes in customer demand, opinions about the company or complaints about specific products or services. As an example, EBay customers post an average of 10,000 messages each week to share tips, point out glitches, and lobby for changes in the EBay platform (Hof, 2001).

Knowledge oriented tools such as data mining tools help organizations to make sense of large datasets and to find patterns, which can be useful in detecting opportunities or threats. A recent example that demonstrates how innovative use of Internet, web 2.0 technology and data mining tools can support sensing and sense-making is the winning campaign of US president Obama in 2008 (see text-box).

> The Obama campaign in 2008 showed the tremendous mobilizing and fundraising potential of a comprehensive Internet strategy. The Obama campaign took advantage of interactive Web 2.0 tools and their social networking capabilities, deploying them as a vehicle for generating excitement among a vast online community (i.e. customer sensitivity). Through a combination of email lists, a community website and internet 'data mining' the Obama campaign was able to segment its supporters, craft different methods of communication for each group and mobilize supporters into volunteers. The data-mining technologies identified potential Republican supporters in every precinct around the country, using technology which predicts voter preferences on the basis of various types of data such as car ownership and magazine subscriptions. Campaign volunteers were sent detailed instructions on whom to visit, including local maps of the area and walking routes, and issues that each potential voter was likely to be most concerned about. This way the Obama campaign was able to sense interests among its supporters and mobilize a response within a shorter amount of time compared to rivals' campaigns. This generated a wave of small-size campaign contributions, which eventually gave Obama a crucial advantage in terms of campaign organization and advertising (in the primaries) over the Clinton campaign, which also raised a large sum of money but mainly from large donors (source: Hill, 2009).

Vigilant information systems *allow information and business intelligence to be integrated and distilled from various sources and systems, detect changes, have active alert capabilities, aid issue diagnosis and analysis, and support communication for quick action* (Walls *et al*., 1992). Business process management, business intelligence and management dashboards are examples of vigilant information systems. Effective vigilant information systems support both the sensing part of the SRL cycle as well as the respond part. Such systems need to incorporate rapid ways of extracting assumptions for decision models and be able to incorporate new parameters that did not previously exist. This means a constant re-evaluation of decision models when weak signals are sensed that may change them (Carlsson and Sawy, 2008).

How IT supports responding

IT capabilities enabling response can be divided into intra-organizational technologies and applications (enabling operational agility) and inter-organizational technologies (enabling partnering agility). IT capabilities can support process-reach or process-richness. Sambamurthy *et al*. (2003) defined digitized process-reach as "*the extent to which a firm deploys common, integrated, and connected IT-enabled processes*". High reach is associated with processes that tie activity and information flows across departmental units, functional units, geographical regions, and value network partners. Examples of technologies facilitating intra-firm process-reach and response are Enterprise Resource Planning systems, Customer Relationship Management systems, groupware, product data management tools, tools for integration of business processes (middleware) and reconfiguration of business processes (Business Process management tools). Examples of technologies facilitating inter-firm process-reach and response are supply chain systems, community systems, collaborative platforms and portals. Van Heck and Vervest (2007) discuss companies that offer complete business network platforms to support partnering agility and collaborative work. Examples of such platforms are Amazon, eBay, and Skype. The success of these business network platforms relates to a large degree to the network externalities. The value of membership to one user is positively affected when another user joins and enlarges the network (Katz and Shapiro, 1994). The more users, the more useful the network becomes, the more difficult it becomes to switch, and the less likely the user will move to another network (Van Heck and Vervest, 2007).

Sambamurthy *et al*. (2003) define digitized process-richness as "*the quality of information collected about transactions in the process, transparency of that information to other processes and systems that are linked to the primary process and the ability to use that information to reengineer the process*". Examples of technologies facilitating process-richness and response are decision support tools and tracking technologies such as Radio Frequency Identification.

How IT supports learning

IT can support knowledge management and learning by providing and supporting knowledge reach and knowledge richness. Sambamurthy *et al*. (2003) define knowledge reach as "*the comprehensiveness and accessibility of codified knowledge in firm's knowledge base and the interconnected networks and systems for enhancing interactions among individuals for knowledge transfer and sharing*". Examples of technologies enabling knowledge reach are Intranets, databases and knowledge repositories.

Sambamurthy *et al*. (2003) define knowledge richness as "*the systems of interactions among organizational members to support sense-making, perspective sharing and development of tacit knowledge*". Examples of technologies enabling knowledge richness are advanced knowledge technologies, virtual video-conferencing systems and collaborative tools for knowledge sharing, such as wikis and web-spaces. Another group of technologies enabling knowledge richness helps organizations to identify patterns within and extract knowledge from data on past transactions. Examples of these technologies are data warehouses, data mining, OLAP, and other reporting tools. Also IT tools based on machine learning, Bayesian networks and social network analysis can support organizations to find and explain patterns and relationships. Since these technologies can help firms to make sense out of apparent noise (Haeckel, 1999) they directly enhance a firm's sensing capabilities. Ashrafi *et al*. (2006) describe different examples of IS which support knowledge quality and different stages of the knowledge management process (acquisition, distribution, identification and exploitation).

The importance of IT in relation to knowledge management and learning capabilities depends to a large degree on the knowledge management strategy that a firm uses. In the codification knowledge management strategy, knowledge is carefully codified and stored in databases (people-to-documents approach). There, it can be accessed and used easily by anyone in the company. In this strategy IT is used in the form of electronic document systems that codify, store, disseminate and allow reuse of knowledge. On top of these electronic repository systems search engines are used to find relevant knowledge. This strategy is emphasized by companies that pursue an assemble-to order or service strategy that reuses existing knowledge. In the personalization knowledge management strategy, knowledge is closely tied to the person who developed it through personal experience. In this strategy (tacit) knowledge is shared mainly through person-to-person contacts and IT is used to facilitate conversations and exchange of tacit knowledge (e.g. people-finder databases). This strategy is emphasized by companies that pursue highly customized service offerings or product innovation.

Although IT can be an important tool for enabling knowledge management and learning capabilities, its significance should not be overrated. Many knowledge management initiatives fail, due to their focus on the implementation of a new IT system for knowledge sharing, while the human side of knowledge exploitation is ignored (Davenport and Prusak, 1997).

Alignment between IT support for sensing, responding and learning

Overby *et al*. (2006) distinguish between knowledge-oriented IS (such as knowledge management systems, data warehouses) and process-oriented IS (such as ERP software). Knowledge-oriented IS are more directly supportive of a firm's sensing and learning capabilities, while process-oriented IS are more directly supportive of a firm's responding ability. Process-oriented systems often provide raw data input for knowledge-oriented systems such as data warehouses, although knowledge-oriented functionality such as reporting is often built directly into the process-oriented IS. Eventually, knowledge oriented and process oriented IS can empower individual (business) users and managers in the different process steps as part of the SRL-cycle with the aim to achieve higher levels of business agility performance. Depending on the type of event, the level of uncertainty, the required response level (operational, tactical or strategic) and the sourcing strategy with regards to different dimensions of agility (operational, customer and/or partnering agility) specific IT capabilities will be more or less important for an organization to be agile.

2.3.6 Business-IT alignment

Since the early nineties, aligning business (strategies) with information technology (strategies) to increase organizational performance has received much attention in the literature (for example Sambamurthy and Zmud, 1992; Luftman and Brier, 1999; Bharadwaj, 2000; Mata *et al*., 1995). Business-IT alignment relates to alignment between business and information technology strategies and between organizational and information systems infrastructures (Henderson and Venkatraman, 1993). It is defined as '*the extent to which the IT mission, objectives, and plans support, and are supported by, the organization's mission, objectives, and plans'* (Hirschheim and Sabherwal, 2000). This alignment creates an integrated organization in which every function, unit, and person are focused on the organization's competitiveness. This is illustrated in Figure 2.8.

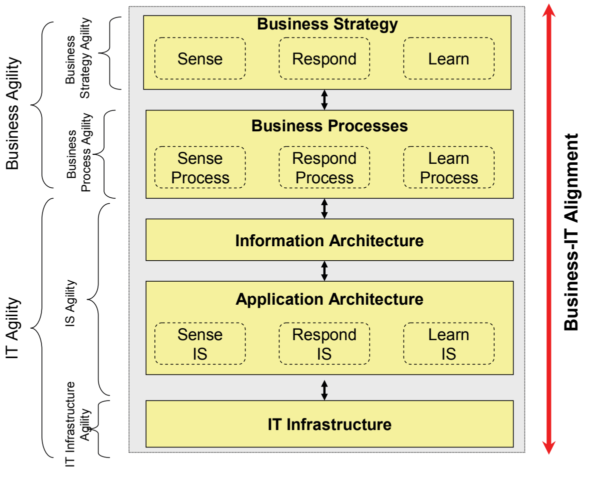

Figure 2.8 – Business-IT alignment

Based on a study among 202 managers, the majority from large companies - 59.6 percent employing more than 1000 people - Chung *et al*. (2003) find a strong correlation between IT infrastructure agility and strategic IT-Business alignment. They conclude that the IT strategy must be tightly aligned with the organizational strategy in order for IT infrastructures to be able to facilitate business agility. This close alignment means that IT infrastructures need to be agile, because agility of the IT infrastructure allows the company to develop new processes and applications quickly, which enables business agility. Ross *et al*. (2006) developed a conceptual model which explains under which conditions specific attributes of IT architecture and Business-IT governance mechanisms (standardization and Business-IT alignment) are considered business agility enabling and leading to better performance of the organization. Business-IT alignment is a process of continuous adaptation and change. Bergeron *et al*. (2004) propose that conflicting co-alignment patterns of business strategy, business structure, IT strategy and IT structure will exhibit lower levels of business performance. Research of Tallon and Kraemer (2004) demonstrates that firms in high clock speed industries, such as electronics, financial services, or telecommunications have a significantly harder time in achieving alignment between IT and the business strategy than firms in a low clock speed industry, such as construction and chemicals. Ineffective alignment of IT with business strategy and planning might be caused by the usage of the wrong IT metrics. Many IT metrics are driven by cost and risk as opposed to speed, innovation and business responsiveness; IT agility is rarely measured as part of IT governance (German, 2007). Strategic IT-business alignment, however, is not solely based on IT infrastructure agility; is also influenced by managerial IT capabilities, such as interpersonal communications, IT governance, enterprise architecture, the capability to demonstrate IT value and IT-business partnerships (Luftman, 2000; Luftman, 2003; Poels, 2006).

2.4 How IT capabilities influence Business Agility

2.4.1 Introduction

Different researchers have studied if and how IT capabilities contribute to higher levels of business agility performance (e.g. Byrd and Turner, 2001; Weill *et al*., 2002; Sambamurthy *et al*., 2003). This research builds upon research on IS investment in relation to productivity, firm performance and competitive advantage (Dedrick *et al*., 2003; Aral and Weill, 2007). In a recent survey of Cap Gemini (2007) among 300 CIOs worldwide, 87% of respondents believed that the capability of the IT function is critical for achieving business agility. All organizations with high perceived business agility also scored high on IT agility, suggesting a correlation between IT agility and business agility (Cap Gemini, 2007:15). A strong correlation was found between business performance and the degree of agility within the organization (Cap Gemini, 2007:13). The question is, whether IT agility directly influences business agility or whether there are mediating effects or variables? And how does this relationship perpetuate itself?

2.4.2 Direct and indirect effects of IT capabilities on Business Agility

IT capabilities can have both direct and indirect impacts on business agility and organizational performance. Haeckel (1999) argues IT capability directly supports sensing and responding capabilities in contemporary environments. Firms increasingly need to process growing amounts of information, for instance detailed tracking & tracing data and RFID data. IT systems enable firms to make sense out of this data, while humans have only limited levels of information processing capacity and are faced with information overload. Similarly, responses in contemporary environments are often too complex for timely implementation without such IT support as communication infrastructure and automation. IT capability is critical for responding to opportunities in IT-driven industries such as financial services, retailing, telecommunications, and hardware/software (Sambamurthy *et al*., 2003).

Recent research takes a process view of IT and argues that the effects of IT are indirect and should occur at the level of organizational processes that use the IT resources (Sambamurthy *et al*., 2003; Tallon and Kraemer, 2004; Mithas *et al*., 2008). Barua *et al*. (1995) analyzed the causal chain between IT investment and firm performance by looking at the effect of IT on intermediate variables. They proposed a two-stage model that first incorporates the impact of Electronic Data Interchange on intermediate process outcomes, and then measures the impact of the intermediate process outcomes on aggregate firm performance. Using the ‘Management Productivity and Information Technology’ database for 60 business units from 1979 to 1983, they found that IT was positively related to three of the five intermediate measures. Their results support using the two-stage model for evaluating the impact of IT on firm performance through intermediate processes. Mooney *et al*. (1996) argue that firms derive business value from IT through its impacts on intermediate business processes. Intermediate processes include the operational processes that comprise a firm’s value chain and the management processes of information processing, control, coordination and communication. Research of Bhatt *et al*. (2005), among 202 manufacturing firms, finds no significant direct relationship between the quality of the IT infrastructure and firm competitive advantage. They suggest that the quality of the IT infrastructure may not directly contribute to differential performance, assuming an indirect effect. However, a lack of quality IT infrastructure could be a serious disadvantage, as it becomes a competitive necessity for firms.

Based on a survey among 236 firms, Xia and King (2002) argue IT infrastructure has a significant indirect effect on organizational performance through its impacts on IS functionality effectiveness and business process effectiveness. They conclude that it is the manner in which IT infrastructure investments are applied to enhancing IS functionality performance and to improving business processes, that is key to realizing their business value. Research of Zhang and Sharifi (2007) shows that firms that develop distinctive organizational culture and structure that align with its IS investments achieve higher levels of strategic flexibility. When IS are used to support development of distinctive organizational capabilities (such as business agility), complemented by firm-specific organizational culture and structure, IS can be a source of competitive advantage.

Aral and Weill (2007) argue that investments into different IT assets are guided by firms' strategies (e.g., cost leadership, business agility) and deliver value along performance dimensions consistent with their strategic purpose. Based on a study among 147 US firms, they hypothesize that firms derive additional value per IT dollar through a mutually reinforcing system of organizational IT capabilities built on complementary practices and competences. In particular, having tight relationships between business units and the IT function, the existence of strong cross-functional IT and business skills (human resources capabilities), and greater digitization of important business processes supports integration of infrastructure with new applications; in turn, enabling firms to more efficiently and effectively utilize applications to improve a broader set of performance dimensions beyond market value (Aral and Weill, 2007).

Investing in agility on the IT infrastructure layer produces high up-front implementation and restructuring costs. However, this supports future business value by enabling new applications (i.e. IS agility) and reducing long-term costs through integration, creating a pattern of lagged benefits (Duncan, 1995; Weill and Broadbent, 1998; Broadbent *et al.*, 1999). The benefits of IT infrastructure agility are lagged, because new applications that leverage a new infrastructure take time to deploy, and important organizational factors such as time for learning and decision-making governance mediate their implementation and use (Aral and Weill, 2007).

2.4.3 Sustainability of the effects of IT capabilities on Business Agility

A number of authors pose that (strategic) benefits of Information Technology are not sustainable over time. A factor which can mitigate positive and sustainable effects of IT agility on business agility is the IT-flexibility paradox, discussed by Lucas and Olson (1994). Technology can contribute to organizational flexibility (and business agility) since (new) IT is inherently more flexible (and agile) than its predecessors. However, since technology ages so rapidly and becomes hard to maintain flexibility (agility) is quickly lost.

IT has a number of characteristics of infrastructural technology (Carr, 2004), such as use as transport mechanism, increased standardization, homogenization of its functionality and its replicability. The popularity of the Internet has accelerated the commoditization of IT by providing a perfect delivery channel for generic applications (web services). Best practices are quickly built into software or otherwise replicated. All these characteristics lead to a rapid price deflation. Carr (2004) therefore states that *IT does not matter*: companies and IT managers should take a more defensive posture toward IT (investments). To illustrate the sustainability of the effects of IT on competitive advantage, Welborn *et al*. (2005) introduce the concepts of codification and semantic stack as important measures for organizational agility. Codification refers to "*the codifying of tacit knowledge into frameworks, standards and executable activities* (Welborn *et al*., 2005)". The semantic stack refers to a simple grid, with the degree codification on the horizontal dimension and the different layers of the enterprise architecture on the vertical dimension. These measures explain how the competitive landscape is changing and the role of IT agility (as enabler for business agility) is moving up the semantic stack from the IT platform layer to the process and strategic layers. In other words, IT agility on the infrastructure layer has become codified and standardized to such a degree, that it has become infrastructure technology with no sustainable advantage.

Keen (1991) stresses that an IT architecture is not a commodity, it is the main attribute responsible for providing a sustainable competitive advantage. Although individual technology components are commoditized to a large degree, the architecture is the structure that binds the different components, removes the barriers of system incompatibilities and makes it possible to build a corporate platform for launching (new) business applications (Keen, 1991).

2.4.4 Firm size and the relationship between IT capabilities and Business agility

Research of Tallon and Kraemer (2004) suggests that small firms are in a better position to convert IT infrastructure agility into increased firm performance. They do not elaborate about the reasons for this difference compared to larger firms. Based on a literature review, Celuch *et al*. (2007) suggest a number of differences between small firms and large firms regarding business agility (i.e. strategic flexibility). Large firms attain business agility through over-investment in strategic options (such as IT infrastructure) that are not necessarily fully exploited by the organization, while small firms are more likely to achieve business agility as a result of entrepreneurial alertness and faster response and implementation times.

2.4.5 Influence of people and their social capital

Recent research of CapGemini (2007) among 300 CIOs worldwide finds capabilities of people (employees and management) to be the most important means for enhancing business agility (see Figure 2.9). The research of CapGemini shows that roughly 50% of the effects of IT on business agility are determined by people, followed by processes and systems. IT employees should have the proper skills and mindset for agility and they are responsible for the relationship between business and IT. CapGemini concludes that the key success factor for successfully achieving IT agility is to foster a corporate culture, skill-set and attitude that inspire employees to become agile in their outlook.

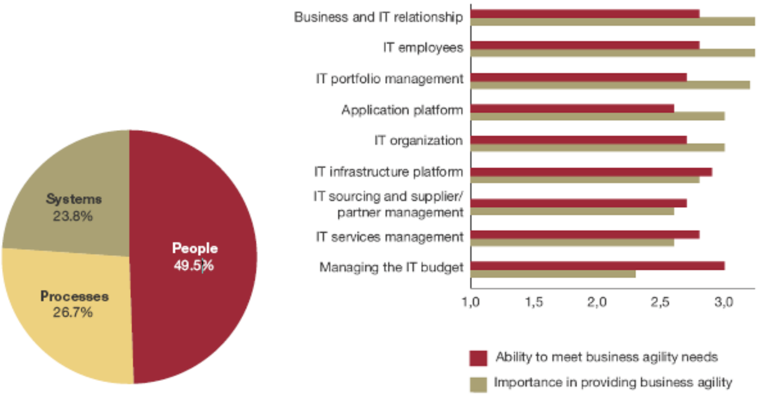

Figure 2.9 - Importance of IT domains in managing Business Agility (Cap Gemini, 2007: 15) (n=300)

Clark *et al*. (1997) characterize an organization's ability to rapidly develop and deploy critical IT systems as its change-readiness capability, and attribute it primarily to the availability of a skilled internal IS workforce. Effective collaboration for problem solving, knowledge sharing and innovation is key to realizing the business value of employees (Gray, 2000; Gold *et al*., 2001). Byrd and Turner (2001) argue that the most important component of a flexible IT infrastructure, responsible for differences in competitive advantage, is IT personnel, followed by integration and modularity. Their results are based on a survey among 207 respondents in medium to large sized companies. The IT personnel construct consists of technical skills, boundary skills (skills and knowledge to assume roles outside area of training or original competences), functional skills (understanding business processes) and technology management (defined as the organizations' ability to deploy IT in the most effective possible manner in support of the business strategies). These findings are congruent with those of Weill (1992), who explains that differences in organizational results from IT investments can be explained by IT personnel. Specifically, the magnitude and quality of the knowledge, skills and experiences of the IT personnel in developing major software applications explain the differences in organizational results. Technical and managerial IT skills typically evolve over long periods of time through the accumulation of experience (Katz, 1974), which explains their tacit nature and importance in contributing to competitive advantage and agility.

IT needs certain levels of social embeddedness in order to contribute to business agility. The construct 'social capital' can be used to analyze this social embeddedness. Social capital refers to '*network ties of goodwill, mutual support, shared language, shared norms, social trust, and a sense of mutual obligation that people can derive value from. It is understood as the glue that holds together social aggregates such as networks of personal relationships, communities, regions or even whole nations'* (Huysman and Wulf, 2004). Newell *et al*. (2004) distinguish between two forms of social capital –internal bonding social capital and external bridging social capital. Internal bonding social capital relates to internal ties, shared purpose and internal cohesiveness of a group. External bridging social capital relates to the (informal) relationships among people. Individuals who provide a bridge across divided communities are important, since they play a brokerage role and can provide access to (dispersed organizational) knowledge of others. There needs to be a strong social capital bond within a team to effectively integrate knowledge that is acquired though bridging social capital (Newell *et al*., 2004).

2.4.6 Influence of managerial IT skills

Previous researchers have analyzed the relationship between IT capabilities and business agility as a managerial issue (Rockart and Short, 1989; Jarvenpaa and Leidner, 1998; Bharadwaj, 2000; Weill and Ross, 2004). This stream of research builds upon previous studies, which found that managerial IT skills were the only IT attribute providing firms with sustainable competitive advantage (Mata *et al*., 1995). Keen (1993) takes a 'fusion' perspective towards IT success, which is based on a fusion of people, business, and technology resources, with the 'management difference' producing the critical, distinctive advantage. Key challenges for IT management in relation to agility are achieving connectivity among the different components and IS of the enterprise architecture, (maintaining) the required skill-set of their (IT) personnel and integrating emerging technologies and applications within the existing IT landscape (Schelp and Winter, 2007). Recent interest in IT governance identified that the risk of ineffective IT management could result in IT rigidity (Bharadwai, 2000; Jarvenpaa and Leidner, 1998; Weill and Ross, 2004). Examples of ineffective IT management are weak cost control or project oversight, ineffective strategic planning, distrust in end-user relationships or a lack of standards.

Based on a survey among IT and business executives in 241 firms Tallon (2008) finds that managerial and technical capabilities affect business agility. Managerial IT capabilities have a direct and indirect effect on agility. Managerial IT capabilities based on IT-business partnerships, strategic planning, and ex-post IT project analysis lead to the development of technical IT capabilities associated with agile IT infrastructure (i.e. IT agility), which in turn drives business agility or a firm's ability to react to change in its products and markets. Tallon (2008) also analyses how volatility (environmental dynamism) moderates the link. In a stable setting, IT agility (technical IT capabilities) is more important to agility than managerial IT capabilities, while in a dynamic setting, the opposite is true. One of the reasons for this difference is that organizations in dynamic settings most probably already have an agile IT infrastructure. Tallon concludes that effective models of managerial IT governance are essential for delivering superior agility or adaptiveness for firms operating in volatile markets.

Table 2.7 summarizes previous empirical research on the relationship between IT capabilities, business agility dimensions, business agility and business performance.

Table 2.7 - Overview empirical research relating IT (agility) with business agility and business performance

Reference	Research Methods and sample	Results
(Aral and Weill, 2007)	Survey among 147 US firms (58% manufacturing, 42% services firms)	Investing in different architecture layers of IT has different effects on performance. The effects of IT Agility (infrastructure) on Business Agility are lagged.
(Barua *et al*., 1995)	Analysis MPIT dataset (60 business units in manufacturing)	Indirect effects of IT capabilities on Business Agility via dynamic capabilities.
(Bhatt and Groger, 2005)	Survey among 202 manufacturing firms	No direct effect of IT Agility on Business Performance.
(Broadbent *et al*., 1999)	Case research in 26 firms	Firms with greater emphasis on the need to change products more quickly will have more extensive IT infrastructure capabilities.
(Byrd and Turner, 2001)	Survey among 207 IT managers of various Fortune 1000 companies	IT Agility is related to Business Performance. The effect is mainly determined by IT personnel.
(Carr, 2004)		Effects of IT capabilities on Business Performance are not sustainable.
(Celuch *et al*., 2007)	Survey among 160 small firms	IT strategic alignment mediates relationship between IT budget and Business Agility. Business Agility mediates the relationship between IT strategic alignment and Business Performance.
(Chang and	Survey among 120 companies	IT systems performance (including quality, responsiveness and flexibility), relates to data effectiveness (including data quality, data accessibility and data flexibility) which relates to service

Reference	Research Methods and sample	Results
King, 2005)		performance (including responsiveness and flexibility).
(Duncan, 1995)	Delphi study (open survey and group discussion) among 21 firms	Effects of IT capabilities on Business Agility are lagged.
(Haeckel, 1999)		Direct effects of IT capabilities on Business Agility.
(Lee *et al.*, 2007)	Survey among 178 Chinese companies (mainly manufacturing)	The complementary relationship between operational innovation capability and explorative IT capability defines level of entrepreneurial agility. The complementary relationship between operational excellence capability and exploitative IT capability defines level of adaptive agility. There are distinctive effects of the two types of IT-enabled organizational agility on generating sustainable competitive advantage: entrepreneurial agility leads to a higher level of barriers to erosion than adaptive agility, and adaptive agility leads to a higher level of profitability than entrepreneurial agility.
(Lucas and Olson, 1994)	Case studies on 2 industries and 3 companies	Information technology contributes to flexibility by 1) changing the nature of organization boundaries and the time when work occurs 2) altering the nature and pace of work, and 3) helping firms respond to changing market conditions quickly. But, there are also aspects of technology which can decrease flexibility, such as increasing time, costs and effort to change systems, workflows and organization structure. There may be second-order impacts of flexibility that are not easily predicted, such as technological dependence, unanticipated responses of competitors and complexity. These 2^{nd} order impacts also influence firms' performance.
(Mithas *et al.*, 2008)	Sample of 52 firms and 108 business units, observations from 1999 to 2003 via structured	Information management capability provides the base capabilities through which firms can build higher-order capabilities (i.e. customer management capability, process management capability and performance management capability). In turn, these higher-order capabilities affect various

Reference	Research Methods and sample	Results
	questionnaire	measures of firm performance.
(Overby *et al.*, 2006)	Conceptual paper	IT capabilities indirectly support Business Agility by providing firms with IT-enabled capabilities in the form of digitized work processes and knowledge systems. Knowledge oriented IT mainly supports sense capabilities, while process oriented IT mainly supports respond capabilities.
(Piccoli and Ives, 2005)	Review abstracts of 648 articles	A framework is developed which explains four barriers to erosion that capture the potential for IT-dependent strategic initiatives to afford sustained competitive advantage. IT assets and IT capabilities are the response-lag driver behind the IT resource barrier. Once an IT-dependent strategic initiative is introduced, through organizational learning and asset stock accumulation processes, the firm can leverage its leadership position to further strengthen other barriers to erosion.
(Sambamurthy *et al.*, 2003)	Conceptual paper	IT capabilities provide the platform for digital options, which enable Business Agility. Entrepreneurial alertness facilitates the leveraging of IT competence into digital options.
(Sengupta and Masini, 2008)	Case studies	Range-agility provides firms with the ability to add variety to its products, routines and practices, as well as to create and sustain webs of collaborative relationships and extend reach. Time-agile companies can seize opportunities for creating advantage through their ability to reconfigure processes and organizational resources faster than competitors. Time-agile infrastructures enable companies to acquire and disseminate knowledge quickly, thereby providing advantages in dynamic markets in which the manipulation of knowledge resources is particularly critical. Both range- and time-agility have positive relationships with a firm's ROA.
(Tallon and Kraemer, 2004)	Survey among 241 US firms	Strategic alignment (IT use) mediates the link between IT Agility and Business Performance. The ambiguous nature of strategic alignment and how IT is used to dynamically support Business Agility can represent a formidable barrier to imitation. Small firms are in a better position to convert IT infrastructure flexibility into firm performance. Firms in high clock speed industries need to focus

Reference	Research Methods and sample	Results
		even more on building a flexible IT infrastructure in order to achieve the same degree of strategic alignment as firms in less volatile situations.
(Tallon, 2008)	Survey among 241 US firms	Indirect effects of IT Agility on Business Performance via Business Agility dimensions. In dynamic environments people agility is a more important means for achieving business agility than IT agility.
(Weill *et al.*, 2002)	Results based on four studies regarding 180 business initiatives in 118 businesses in 89 enterprises from 1990 to 2001, based on detailed interviews, extensive questionnaire data and personal visits	Significant correlation between strategic agility and IT-infrastructure capability, based on an analysis of what IT infrastructure are needed to implement a set of strategic initiatives the company desires to implement. Differences were found in infrastructure capabilities depending on whether a company was pursuing initiatives in new products or new markets. Investing in IT infrastructure is like buying an option. If used successfully, infrastructure enables faster time to market; if not, it will prove an unnecessary cost. Successful enterprises get the infrastructure balance right because they make regular, systematic, modular and targeted investments in IT infrastructure on the basis of an overall strategic direction.
(Welborn *et al.*, 2005)	Conceptual paper	Indirect effects of IT capabilities on Business Agility and Business Performance via sensing, responding and learning. The impact moves from infrastructure layer to process and service layer.
(Xia and King, 2002)	Survey among 236 firms	Indirect effects of IT Agility on Business Performance via Business Agility dimensions.

2.5 Synthesis

2.5.1 Summary of literature

This chapter reviewed previous literature on business agility, IT agility and explored possible relationships between IT capabilities and business agility. Business agility is defined as *the ability of an organization to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected but potentially consequential internal and external events, based on the capabilities to sense, respond and learn*. The level of business agility of a firm is determined by the availability and relationship among three groups of dynamic capabilities: sensing-, responding- and learning capabilities. These capabilities can be sourced internally or acquired via partners or via customer inclusion.

IT agility is defined as *the ability of Information Technology to support an organization to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected but potentially consequential internal and external events*. Most of the previous IS literature on IT Agility explored the structural characteristics of IT infrastructure agility (e.g. Nelson and Cooprider, 2001; Weill *et al*., 2002) and (methods for) agile software development (e.g. Abrahamsson *et al*., 2002; Nerur *et al*., 2005).

The literature review revealed three streams of literature with different perspectives on the relationship between IT capabilities and business agility (performance). The first stream of research claims that IT capabilities are a necessary condition for higher levels of business agility (performance) (e.g. Keen, 1991; Byrd and Turner, 2001; Weill *et al*., 2002; Sambamurthy *et al*., 2003; Sengupta and Masini, 2008). Specifically, organizations with a higher level of IT architecture maturity (i.e. more structural IT agility) are better positioned in achieving business agility (Ross *et al*., 2006). This stream proposes that a lack of a quality IT infrastructure can be a serious disadvantage, as it becomes a competitive necessity for firms.

The second stream of research claims that IT capabilities contribute to higher levels of business agility (performance) under certain conditions and for certain events. The quality of the IT infrastructure (structural IT agility) does not directly contribute to differential business performance (Bhatt *et al*., 2005). The effects of IT capabilities on business agility and business performance are mainly indirect and mediated by sensing, responding and learning (Overby *et al*., 2006). The benefits of IT Infrastructure agility are lagged, because new applications that leverage new infrastructure take time to deploy, and important organizational factors, such as time for learning and implementing decision-making governance, mediate their implementation and use (Aral and Weill, 2007). Tallon (2008) points to the managerial IT capabilities that lead to the development of technical IT capabilities associated with agile IT infrastructure, which in turn drives business agility or a firm's ability to react to change in its products and markets. Important factors that influence the relationship between IT capabilities and business agility are skills of employees, (informal) relationships among people (social capital) and the managerial capabilities to align business with IT. Upton (1994) points out that many of the disappointments with emerging technologies may be the result of a failure to consider the people side of agility.

The third stream of literature claims that IT capabilities do not really matter in relation to achieving superior business agility performance. This literature stream criticizes the degree in which IT can bring sustainable benefits (Carr, 2004). IT can even hamper business agility due to the rigidity of IT and increasing complexity of systems evolving over-time (Lucas and Olson, 1994; Hagel and Brown, 2001; Attaran, 2004; Reddy and Reddy, 2002; Rettig, 2007).

2.5.2 Conceptual Model

Based on the literature study a conceptual model is developed in Figure 2.10. The conceptual model includes all the constructs that will be studied in the empirical studies and the expected relationships among the constructs.

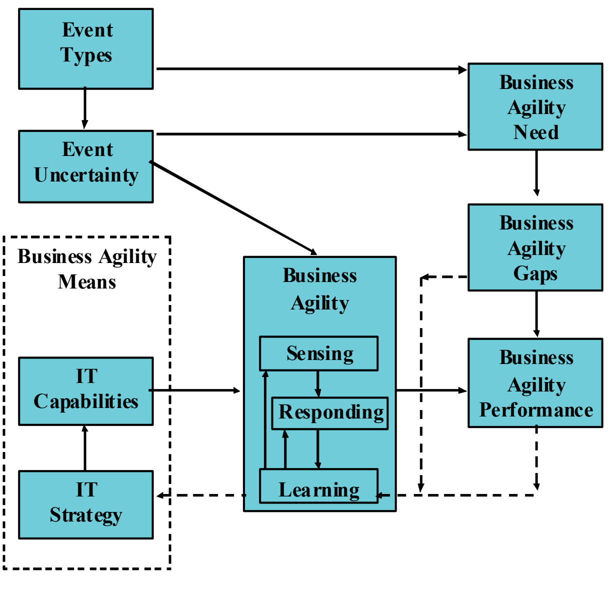

Figure 2.10 – Conceptual model

The model distinguishes between event types, event uncertainty, business agility need, IT capabilities (one of the means for enhancing business agility), business agility (with sensing, responding and learning as three dimensions), business agility performance and business agility gaps. The most important dependent variable is business agility performance, which has been defined as *the performance of an organization in swiftly changing businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events*. The literature review reveals two types of alignment that explain (a lack of) business agility performance. SRL alignment refers to *the maturity, balance and relationship between sensing, responding and learning (IT) capabilities*. Business-IT alignment refers to *the alignment between business and IT and the alignment between the different layers of the enterprise architecture*. This is illustrated in Figure 2.11.

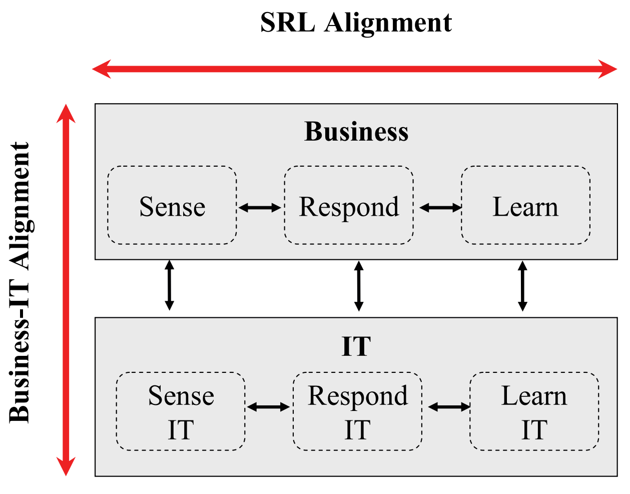

Figure 2.11 – Analyses of alignment

Firms that score *high* on SRL alignment and also score *high* on Business-IT alignment are expected to have *high* business agility performance levels. These firms are able to sense disruptions or opportunities, respond quickly and learn from each event to further improve sensing and responding. The IT of these firms is aligned with the business. In the event that modifications are required in processes and IT (as part of the response process), those modifications can be achieved relatively quickly and easily. Culture and organizational structure in these firms enable people to sense, respond and learn. Firms that score *low* on SRL alignment and also score *low* on Business-IT alignment are expected to have a *low* business agility performance. These firms have not embedded the SRL-cycle in their organization. Processes probably are still organized functionally or geographically, each with their own stove-pipe IT systems and people are not empowered to sense, respond and learn. In these firms business and IT are insufficiently aligned. In the event that modifications are required in processes and systems, this takes a lot of time and costs. Firms that score either *low* on SRL alignment or on Business-IT alignment and *high* on the other are expected to have *medium* business agility performance levels. Figure 2.12 illustrates how SRL alignment, Business-IT alignment and business agility performance are related.

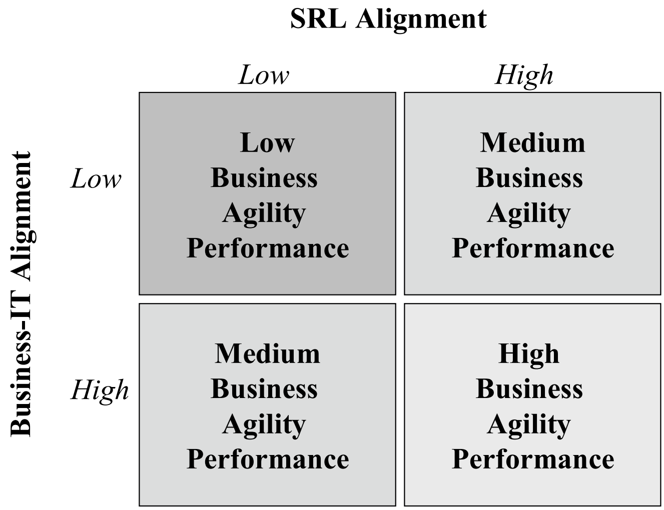

Figure 2.12 – Business Agility Performance Matrix

A third type of alignment which is a relevant part of the conceptual model is the alignment between business agility performance and business agility need. Business agility performance should be continuously fine-tuned to the business agility need. Any effective system must be as agile as its environment forces (Dove, 2005). This is one of the critical requirements of learning capabilities In case there is a mismatch between the need for business agility and the business agility performance, there is a business agility gap. Firms try to minimize business agility gaps, since a lack of business agility performance can reduce the competitive position of a firm, while a surplus of business agility performance can be very expensive. Sense-Respond-Learn alignment and Business-IT alignment are discussed in more detail in the next sections.

2.5.3 Sense-Respond-Learn alignment

There are different possible reasons for a lack of SRL alignment. Firms simply can have insufficient sensing-, responding- or learning capabilities. A lack of sensing capabilities leads to missing out on innovation opportunities or being insufficiently responsive to disruptions and calamities. Sensing capabilities can lack the required filtering for relevancy, which can lead to information overload. As such, biases in sensing can lead to overlooking opportunities or risks. A lack of response capabilities can be attributed to response design or response implementation problems. A response design problem can be due to the fact that alternative designs cannot easily be configured or experimented with (a requirement, discussed by Prahalad *et al*., 2002). Response implementation can take a long time, due to long decision-making cycles, insufficient (access to) organizational memory or a lack of IT tools for collaboration and decision-making. With regards to learning capabilities, there can be uncertainty about response effects, due to a lack of organizational memory (IT) regarding previous cause-response-effect relationships. Also insufficient feedback mechanisms for reflection and learning can lead to a lack of adjustment and reconfiguration of sensing and responding capabilities.

If firms develop their sensing-, responding- and learning capabilities unequally, this can also lead to a lack of business agility performance. Overby *et al*. (2006) discuss the symbiotic relationship between sensing and responding capabilities. They argue that each of these components is needed for a firm to be agile. Learning capabilities strengthen sensing and respond capabilities and co-operate jointly in a beneficial cycle. Firms might be able to sense environmental change relevant to their business (high sensing) but fail to respond to it in an agile manner (low responding). It is also conceivable for firms to have strong responding capabilities (high responding) but be unable to sense the disruption or identify an opportunity worth pursuit (low sensing). This lack of sensing may be due to several factors, such as lack of transparency on organizational memory due to different data formats or lack of integration among corporate systems. If one specific capability is insufficiently developed, this can lead to a business agility gap with negative effects on business agility performance. As an example, data is captured (data acquisition capability), but analysis of the data (sense-making i.e. data assimilation) is not developed sufficiently. This means there will be no response to the event, simply because the event was not noticed (in time) within the firm. Strong responding capability can provide incentives for a firm to look for emerging opportunities, thereby improving its sensing capability (Overby *et al*., 2006). One of the key challenges for organizations is to find mechanisms for linking sensing-, responding- and learning capabilities and to manage the overall process. Sensing-, responding- and learning capabilities should be treated as an ecosystem of dynamic capabilities, which are mutually interdependent and connected via IT and human interfaces.

Firms that are organized according to a generation of corporate transformation that precedes 'business agility' face a lack of SRL alignment, since their organization, business processes and IT are not designed as a SRL-cycle across the enterprise. Sambamurthy and

Zmud (2004) claim that organizations should progress through the different phases of progression as part of the learning process. This implies that companies should invest especially in learning capabilities, if they need to migrate from previous generations of corporate transformation to business agility. Changing organizations towards a SRL-organizational structure is very challenging from a managerial perspective.

Firms that are not organized according to the principles of SRL face challenges in using their IT to support and link sensing, responding and learning. The integration among sensing, responding and learning applications on the application architecture layer requires coupling of structured applications with (more) unstructured applications while also sharing and combining data of different corporate and local IS. A key challenge is the integration of emerging internal and external applications and (outsourced) services with existing technology applications. Managers should be able to integrate data from multiple sources to have information that is relevant and meaningful in a given decision context as part of the response process (Prahalad *et al*., 2002). Stovepipe (functional) IS which characterize lower levels of enterprise architecture maturity cause SRL misalignment, since it is difficult to interface the different systems: sensing IT is not linked to responding IT and learning IT is not linked back to sensing IT and responding IT. An important reason for SRL misalignment relates to the difficulty of integrating response capabilities of ERP with the organization's culture and sensing and learning capabilities.

2.5.4 Business-IT alignment

Business-IT alignment relates to *the alignment between business (requirements) and IT and the alignment between the different layers of the enterprise architecture*. One of the major business-IT alignment challenges relates to alignment across the different layers of the enterprise architecture to drive executional consistency (Welborn *et al*., 2005). A lack of integration may hinder information flows within a firm and with business partners, harming its overall business agility performance. Major conflicts can be caused by the existence of legacy systems and the integration of information systems or components as part of a heterogeneous IT landscape, common to many firms. This leads to low levels of connectivity and standardization, limited data transparency and many connections between components and applications, yielding high levels of complexity. As a result, IT can have various conflicting effects on an organization's level of business agility, depending on the IT agility level of specific information systems or components of the IT infrastructure. Such heterogeneous IT landscapes limit IT agility, create high costs for maintenance and integration and leave little room for renewal and innovation. More recent approaches to IT agility try to take this IT inheritance into account.

Often there is a lack of visibility regarding the effect of change in one layer of the enterprise architecture on systems, components or linkages in other layers of the enterprise architecture. Responding to uncertain events often requires making changes in the business process layer, however this does not automatically lead to changes in the underlying architecture layers (applications, data, IT infrastructure). Information systems often lack up-front reconfigurability (because business rules are embedded) and are vertically integrated (with tightly coupled presentation, logic and data). The use of highly structured enterprise systems can also lead to business-IT misalignment, since such systems freeze the relationship between business processes, applications and data (Rettig, 2007). These systems support response for predictable change, but lack agility to quickly respond to unpredictable changes.

In addition to these structural causes for a lack of business-IT alignment there are also social causes, such as a lack in communication between business and IT and insufficient business expertise among IT personnel (Luftman, 2000; Luftman, 2003).

2.5.5 Trade-offs and dilemma's

Firms that need to increase SRL-alignment and business-IT alignment in order to increase business agility performance levels face a number of dilemmas and trade-offs. Some of these dilemmas have a structural connotation (IS design perspective), while others have a social-people connotation (IS adoption and IS use perspective).

The first dilemma is to decide on how much agility really *is* needed. It is relatively expensive to build an IT infrastructure that supports different types of business agility (Ross, 2008). Organizations need to decide on developing a portfolio of dynamic capabilities that best fits the uncertainty in their environment and their overall business strategy.

Business agility performance is not unlimited. Personal and organizational constraints and rigidities set limits to the business agility performance levels of firms. Personal constraints and rigidities include (lack of) entrepreneurial alertness (Sambamurthy *et al*., 2003), cognitive and emotional biases (Schoemaker and Day, 2009) and existing mental models that can cloud sensing, responding and learning (Senge, 1990). Research of Barr *et al*. (1992) found that the main differences in organizations' response times were caused by speeds of change in executive decision makers' mental models. Eventually, every person has an intrinsic need to strive for a certain level of ontological security (Giddens, 1991). "Ontological security" and "existential anxiety" are essential ingredients in Giddens' (1991) theory of human existence. Ontological security refers to a "*person's fundamental sense of safety in the world and includes a basic trust of other people. Obtaining such trust becomes necessary in order for a person to maintain a sense of psychological well-being and avoid existential anxiety*" (Giddens, 1991:38–39). People strive for a state of 'home' as a beacon of security to provide a site of constancy in their social and material environment. People avoid homelessness, which is characterized by impermanence and discontinuity (Kinnvall, 2004). As with any change, "*social failure*" (i.e. rejection of IT by users) of IT (even if the IT will support increased agility) can be an important constraint that limits the level of business agility performance (Upton, 1994).

Designing the SRL-cycle in the organization is also restricted by different organizational constraints and rigidities. Existing leadership style, structure and culture can restrict organizations in changing to a SRL-cycle across the enterprise (Haeckel, 1999). The lock-in to existing partnerships and strategic long-term commitments with network participants can be irreversible thus decrease flexibility and agility of incumbent firms (Ghemawat, 1991, in: Hill and Rothaermel, 2003). Organizational social biases can blur the ability to effectively implement the SRL-cycle (Schoemaker and Day, 2009). Incumbent firms are constrained by incentive rigidities. They invest in incremental and sustaining innovations in extant market contexts (Henderson, 1993; Christensen and Raynor, 2003), while they remain reluctant to embark on development projects, since this could disrupt the lucrative status quo and cannibalize extant revenue streams (Hill and Rothaermel, 2003; Christensen and Raynor, 2003). With regards to partnering agility a (lack of) trust among business partners can lead to a lack of willingness to share information which can hamper business agility performance.

The existence of (biased) legacy information technology is an important constraining factor for achieving higher levels of business agility performance. Data acquisition (scanning) appears to be a highly biased process in which 'noticing' and 'interpreting' are synonyms rather than iterative process steps. Information systems are designed to accommodate certain flows of data from certain sources that are 'designed into' the system (Haeckel and Nolan, 1993). If an information system's design contains 'the wrong reality-or is incomplete, out of date, or operating on bad data – the outcome could be catastrophic' (Haeckel and Nolan, 1993:123). Also the frequency and modes that are used for scanning (data-acquisition) may be determined by mental models of decision makers (Daft *et al.*, 1988). Like their Information Systems, executive decision makers might be 'locked-in' to established contexts and by extension into established information gathering sources and practices.

Another dilemma relates to the amount of agility that can be engineered (upfront) into the enterprise architecture and IS versus the need to have a stable IT platform. The IT industry faces a continuous challenge of fighting complexity and balancing efficiency and stability with agility. Lucas and Olson (1994) discuss the IT-flexibility paradox. "*Technology can contribute to business agility, since (new) IT is inherently more flexible than its predecessors. However, since technology ages so rapidly and becomes hard to maintain, flexibility (and agility) is quickly lost*". It seems that achieving ambidexterity of IS –

balancing stability and efficiency with innovation and IT agility – is a challenging task. Should the firm invest in embedding upfront agility (versatility or reconfigurability) in the design of new IS, or should it rely on (agile) software development methods to be able to quickly (re) construct (new) IS in response to agility requirements (Mårtensson and Steneskog, 1996). A related dilemma is deciding on governance of IT and where to put the controls and the possibility for adaptation. Requirements can differ between the local (business unit) level and the central (corporate) level.

Designing an approach towards learning and knowledge management that best fits the organizational context is one of the critical activities in the enhancement of business agility performance levels. Learning capabilities are required to secure and (on demand) to activate knowledge, which feeds sensing- and responding capabilities. A dilemma for organizations is to decide among or to balance codification knowledge management strategies (linked to IT agility) and personalization knowledge management strategies (linked to people agility and social capital). The choice among these two approaches depends to a large extent on the degree to which knowledge can be codified, the degree to which people are able and willing to share their knowledge and the type of uncertainties businesses need to respond to. One approach can counterbalance the limitations of the other, which implies benefits in a certain level of ambidexterity of a firm's approach towards knowledge management (Hansen, 1999).

A final dilemma in reducing SRL misalignment and business-IT misalignment relates to the sourcing decision on individual (sub)dimensions of business agility. In which dynamic capabilities should the firm specialize (i.e. internal agility)? Which partners should the firm connect with for outsourcing or co-sourcing of certain dynamic capabilities? How can the customer be co-opted in different dynamic capabilities? And how can learning across broad networks of enterprises be accelerated to improve the SRL-cycle? These decisions involve costs and bring risks, due to dependencies outside the direct sphere of influence of the firm. Firms need to balance trust and performance monitoring strategies to track partners' performance levels.

Chapter 3: Agility in Practice

3.1 Introduction

Case studies are an important means to discuss how IT impacts business agility and to explore possible relationships among constructs. Six case studies were selected from existing resources to provide examples regarding the use of different agility strategies by different companies and to gain further insight on business agility, the role of IT capabilities and the relationship with business (agility) performance. The cases are based on a literature study using scientific papers, reports, (Internet) news articles, company case studies and testimonials and blogs. The following critical components were selected from the literature study and the conceptual framework, to be analyzed and illustrated as part of each case study:

1. Analysis of an uncertain event.
2. Analysis of business agility (sub)dimensions (sense-respond-learn cycle).
3. Analysis of how IT capabilities impact business agility.
4. Analysis of business agility performance.

3.2 Case 1: Wal-Mart dealing with Hurricane Katrina [2]

Introduction

Wal-Mart Stores, Inc. is an American corporation that runs a chain of large, discount department stores. Founded in 1962 and incorporated in 1969, it is the world's largest corporation in terms of revenue. There are currently 7,390 Wal-Mart stores and Sam's Club locations in 14 markets worldwide, which employ more than 2 million people, serving more than 200 million customers per year[3].

Business agility: responding to Hurricane Katrina

In August and September 2005, hurricanes Katrina and Rita tested the agility of corporate logistics and supply chain operations in the United States. Companies struggled to move relief supplies and inventory to and from the region before and after each storm (Worthen, 2005). One lesson from these storms is that having procedures in place for communicating quickly about what needs to be done is as essential as having integrated inventory and

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[2] In preparing this case study the following references were used: Worthen (2005), Sullivan (2005) and Scavo (2006).
[3] http://en.wikipedia.org/wiki/Wal-Mart, http://walmartstores.com/AboutUs/

logistics systems. Wal-Mart was able to move food, water, generators and other goods to areas hit by hurricanes Katrina and Rita immediately after each storm, because it has an emergency operations centre that is staffed every day around the clock by decision-makers who have access to all of the company's systems and data. Wal-Mart utilized a dashboard system, developed for the operations centre, that gives the company significant visibility – showing each store's damage, whether employees were at risk or injured, and if the store has communications platforms running and whether they're running on landlines or satellite systems with utility or generator power. The centre is equipped with hurricane-tracking software. On August 24, days before Katrina made landfall, company managers were already planning their response. The emergency response team of Wal-Mart works in a large, open room that was designed to facilitate communication among different functional managers. Wal-Mart trucks were distributing aid to Katrina's victims days before federal relief arrived. During less destructive hurricanes, Wal-Mart ships, on average, between 200 and 400 containers of goods for sale or relief. In the first two and a half weeks following Katrina, Wal-Mart shipped 2,500 containers to the region and delivered another 517 containers post-Rita. Wal-Mart also set up satellite links for its stores that lost phone or Internet service so that they could stay connected to headquarters (Worthen, 2005).

How IT capabilities impact business agility

Wal-Mart regards its IT as its core competency (Brown, 1999). Wal-Mart was one of the first retailers that invested in satellite communication systems and real-time updates of sales and inventory information. Wal-Mart has also been a front-runner in the usage of Electronic Data Interchange and Bar-coding for tracking and tracing of goods. The use of these technologies led to a retailing revolution and made Wal-Mart the clear leader in the industry. Despite attempts by other retailers to copy Wal-Mart's IT, the firm continues to maintain its leadership position, remaining solidly ahead in the learning curve on its leverage of IT (Bharadwaj, 2000).

Information Systems in Wal-Mart are highly standardized and centralized. Wal-Mart runs all worldwide information systems out of its headquarters in Arkansas, with a second data centre providing backup and recovery. In addition to the cost benefits, the single-system approach allows Wal-Mart to leverage best practices, which are embedded in the system, across regions. When executives transfer to a different part of the world, they have the same system and processes that they already know from their previous location. This supports Wal-Mart's leveraging of human resources worldwide. A point-of-sale transaction entered in China comes back to Arkansas for credit card authorization and then returns to China for completion of the sale. The whole process takes place in less than half a second. Wal-Mart real-time data from its point-of-sale terminals provides sensing information about demand fluctuations. The point-of-sale transaction systems capture all the day's sales and product data across its global operations on an hourly basis. This is over $250 Billion in sales per year or $68 million per day – almost $3M per hour.

Besides centralization of core information systems, Wal-Mart also has centralized its core staff. Most of Wal-Mart's developers are working in one place; this allows them to collaborate more easily. Wal-Mart has chosen to have IS staff and IS developers work in close proximity to the commercial and logistics staff. By eating lunch with buyers and talking about issues in retailing, IS developers keep tuned in to the real concerns and needs of the business.

The centralized system supports a certain level of localization via agility that was built into the system upfront. Specific functionalities in the centralized system can be turned on or off to accommodate local needs. In some cases, large blocks of functionality are turned off for small markets, because these would hurt their productivity.

Wal-Mart was one of the first retailers in the early 1990s to build an enormous database of purchasing information, which enables them to understand what each customer buys and the relationship between the items in each customer basket. This has led to more efficient product placement in the aisles and to higher revenues per square footage in its stores (Bharadwaj, 2000).

This data warehouse is part of Retail Link, which was initiated in 1991. Via Retail Link suppliers have access to sales, shipment, orders, returns and other data on their products in Wal-Mart stores. Retail Link has shown the value of making information available to both Wal-Mart and its suppliers. Wal-Mart's recent RFID initiative has also shown the benefits of information sharing and data transparency. Gillette, for example was able to tell from RFID data which stores did not get a product out to the selling floor in time for a new product launch date and was able to discount such stores in their sales analysis. A smaller supplier that provides seasonal Christmas merchandise was able to track pallets through Wal-Mart's distribution chain. They saw that a group of pallets went into a distribution center (DC) but were not moving out to stores. They alerted the DC to the problem, which was able to expedite delivery to stores in time for the holiday season, saving the supplier from having to suffer lost sales and mark-downs.

Analysis

This case shows that Wal-Mart was well prepared to react to hurricane Katrina event. Wal-Mart used its IT capabilities to enable continuous sensing and a quick response, in close collaboration with its partners and suppliers as part of partnering agility. Real-time information visibility on its network of stores, transport resources and goods via point-of-sale and RFID data provided the basis. To sense the (effects of) hurricane Katrina Wal-

Mart generated intelligence via a clever combination of internal data sources and external data sources (hurricane tracking software). The efficient communication among different decision makers due to close physical proximity and information dashboard tools were helpful for quick decision-making and fast response. The highly centralized systems supported quick response throughout the whole organization.

3.3 Case 2: 7-Eleven Japan exploits real-time market information[4]

Introduction

7-Eleven is a worldwide chain of convenience stores. It is, since March 2007, the largest chain store in terms of all financial indicators. Japan has more 7-Eleven locations than anywhere else in the world, where they often bear the title of its holding company "Seven & I Holdings". Of the 34,200 stores around the globe, 12,013 of them are located in Japan. 1,577 are in Tokyo alone[5]. 7-Elevens in Japan offer a wider selection of products and services. Japanese 7-Elevens offer not only food, drinks, and magazines, but also video games and consoles, music CDs, DVDs, digital card readers as well as seasonal items like Christmas cakes, Valentine's Day chocolates, and fireworks. 7-Eleven Japan is a good example of a company that uses information to make more effective business decisions and increase business agility (Aral and Weill, 2007).

How IT capabilities impact business agility

77-Eleven's spectacular success in Japan can be attributed to its management information system, which allows inventory to be turned over as many as 55 times a year (Lee and Whang, 2001). 7-Eleven captures shifts in consumer demand and couples that information to a reactive supply chain design, In order to respond rapidly to updated demand information adjusts supply to stores three times a day (Kopczak and Johnson, 2003). Information is extracted and summarized using transactional IT systems that process thirty-five million Point of Sale (POS) transactions and five million order transactions per day. 7-Eleven's POS is able to capture information beyond simple sales data such as age and gender of the customers – this demographic information is useful to "know your customer better" and hence implement marketing (and operation) tactics. Each day, the POS-data is sent to the 7-Eleven Japan information systems centre, where they are integrated, analyzed, and shared, via informational IT, with all store owners and workers at registers in real time. Within the large amount of data, correlations and substitutions are analyzed in relation to local events and product transitions. The business network architecture and some of the important IT capabilities of 7-Eleven are shown in Figure 3.1.

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[4] In preparing this case study the following references were used: Kotabe (1995), Kopczak and Johnson (2003), Fung (2005), Lee (2007).

[5] http://en.wikipedia.org/wiki/7-Eleven

7-Eleven has shifted responsibility for product selection downward, allowing individual stores to be customized for specific target markets. Store managers are given more power to enhance the company's flexibility in a highly competitive environment. By decentralizing authority, the individual stores are empowered to react more effectively to changes in consumer demand. Relocating much decision-making to the store level has made 7-Eleven more responsive to both customer needs and store-level employee initiatives (Kotabe, 1995).

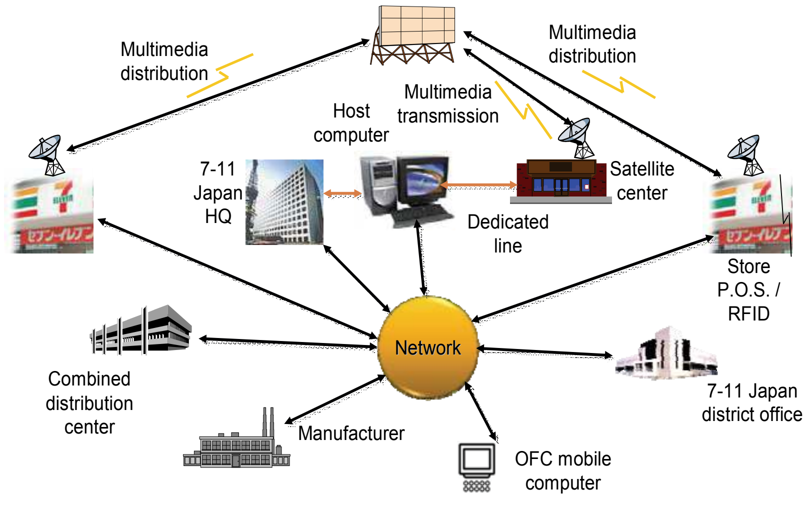

Figure 3.1 - Business network architecture of 7-Eleven and IT capabilities (source: adapted from Hau Lee, 2007)

Analysis

A high level of data transparency coupled to an intelligent process for turning data into useful information to replenish existing and create new products form the basis of business agility for 7-Eleven Japan (Lee and Whang, 2001). 7-Eleven analyzes high quality data and transforms this in useful information (learn capability), quickly shares this information via transactional IT (response capability), uses this information to sense any changes in its performance or changes in customer demand and then takes action if required (response capability). Local store managers are empowered to make decisions and respond to changes in customer demand. Response actions can be changes in localized promotions, dynamic shelving and merchandizing and new product development.

Partnering agility is important in relation to collaboration with suppliers and logistics operators. 7-Eleven uses a responsive and agile supply chain design to achieve replenishment multiple times within one day. Efficiency and cost-savings is achieved via cross-docking by temperature range in a few centralized distribution centers. 7-Eleven's success relies not only on internal effort, but also the partnership among suppliers who commit to 7-Eleven's strategy of agile logistics. Suppliers are penalized if they fail to deliver their products on time. In doing so, 7-Eleven is able to control the lead time and hence reduce safety inventory during lead time.

3.4 Case 3: Microsoft Xbox market introduction

Introduction

In the early 2000s Microsoft decided to broaden its attention from the PC market to the game console market. While a hit PC title can sell several hundred thousand copies, a console hit can sell *millions* of copies. By stepping into this more lucrative arena, Microsoft was challenged by three established players – Sony (PlayStation), Sega (Dreamcast) and Nintendo. Microsoft hoped that the combination of performance and features would be compelling enough to gain a large market share in a short period of time. To a great extent, the Xbox's success or failure depended on how well the PC graphics expertise of Microsoft and partner Nvidia would translate to the console market (Macedonia, 2000). Microsoft needed agility to respond to the competing game consoles by bringing a new more advanced game console to the market quicker than its rivals.

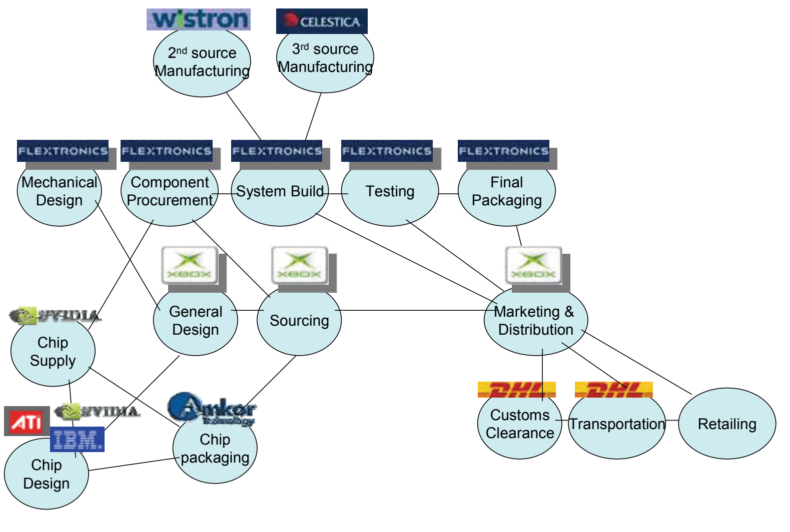

Figure 3.2 - Business network architecture Xbox (source: adapted from Hau Lee, 2007)

Business agility

In developing the Xbox console, Microsoft collaborated with many partners. In fact, the only activities which were kept in-house were the design of the console, sourcing of the components and marketing and distribution. All other activities (manufacturing, system configuration, testing, packaging and transportation) were outsourced to external partners. The business network architecture for the Xbox is shown in Figure 3.2.

How IT capabilities impact business agility

During manufacturing of the original Xbox systems, Microsoft interacted with its contractors through an EDI-based system that sent batch transmissions daily. This solution lacked real-time visibility into the supply chain, resulting in supplier inefficiencies and inventory write-offs. In addition, the tightly coupled nature of EDI required expensive and time-consuming development work to bring each contractor into the solution. Therefore, a new approach was chosen with the development and market introduction of the Xbox 360.

"Without real-time visibility into the semiconductor manufacturing process, we're steering a ship with a blindfold on. We need to be able to see when delays in the stages of supply and production are occurring and when yields are not meeting expectations, so that we can take immediate corrective action. Microsoft is on the hook for supplying its contract manufacturers with the GPUs that go into the Xbox 360. If we don't get those parts to them on time, we can't expect on-time delivery of the Xbox 360 from them." ***Robert Meshew, Group Program Manager, HED—IT Systems, Microsoft.***

Microsoft needed a solution that would validate the data coming from its suppliers, so that there was no delay in requesting and receiving corrected data when necessary. In addition, the solution had to meet vendor acceptance and easy accommodation of future partners. Microsoft decided to deploy a Business Integration and Intelligence (BII) Framework based on BizTalk Server 2004 and on the BizTalk Accelerator for Rosetta Net version 3.0. The BII Framework supports integration with and performance monitoring of the participating customer-owned tooling contract manufacturers and subcontractor suppliers. Microsoft is using BizTalk Server to create standardized (XML) data exchange between the enterprise resource planning (ERP) and shop floor systems that Microsoft contract manufacturers and suppliers use.

"A one-day increase in responsiveness is huge in outsourced manufacturing. It means you have the time to respond to problems… to save thousands of dollars in unnecessary air freight and expediting costs." **Robert Meshew, Group Program Manager, HED–IT Systems, Microsoft Corporation**

The Web-based user interface for the system is a digital dashboard, based on Microsoft Office SharePoint® Portal Server 2003. The SharePoint portal provides the solution's end-to-end visibility into the supply chain through such features as order disposition, inventory reconciliation, and a supplier scorecard that tracks several measurements of supplier performance. Those measurements include actual performance against SLAs for on-time delivery and the quality of supplier information provided to the system, because invalid data (for example, an empty field on a purchase order) can impede the real-time view throughout the supply chain.

Microsoft reported a number of expected (agility) benefits in changing from an EDI-approach to an approach using the BII Framework[6]. '*Using the BII framework is expected to speed the supply chain process while reducing its cost, for a significant first-year ROI to Microsoft. In addition, the solution was relatively fast and cost-effective to develop. Its loosely coupled structure ensures that suppliers can be added later, as needed, without extensive coding or regression testing. As a result of increasing agility throughout the manufacturing process, the BII Framework is expected to increase on-time deliveries by about 20 percent for the next-generation Xbox 360 production. The real-time visibility into the supply chain, combined with tighter integration with supplier work-in-progress processes and Microsoft planning systems, should contribute to a 10 percent reduction in inventory costs*'.

Via integrated information systems, visibility was created on new product release data, general design changes, chip design data and changes, manufacturing design changes, sourcing changes and distribution. In 2001 the X-Box was launched with a time-to market of 14 months. The time-to-market for the Sony PlayStation 2 took about 20 months. Microsoft won a market share in favor of Sony's PlayStation of 3.6% in 4 months time. In November and December 2005, Microsoft launched the Xbox 360 simultaneously in North America and Europe. The Xbox 360 was launched about one year before Sony's PlayStation 3. This generated first-mover advantages for Microsoft (extra market share and revenues) (Lee, 2007).

Analysis

The introduction of the Microsoft Xbox game console is an example of entrepreneurial agility to enter a new market of gaming consoles. The agility was mainly rooted in the time it took to bring a new concept and combination of new technologies to the market using collaboration with external business partners. Microsoft uses a partnering agility strategy, to combine internal capabilities with external capabilities of various business partners. A high level of data transparency and data sharing enables this partnering agility strategy and inter-organizational collaboration between Microsoft and its partners. The decision to change from a closed proprietary technology (EDI) to a more open web based technology (XML and web portal technology) increased quick connect IT capability as part of IT

[6] http://technet.microsoft.com/en-us/library/bb735237.aspx

agility. Visibility and data quality increased and it became relatively more easy for Microsoft to connect with new partners. This generated positive effects on sensing and responding, with a shortened time to market for the new Xbox 360 console in comparison with its closest rival PlayStation 3 of Sony.

3.5 Case 4: Dell computers on-line build-to-order model[7]

Introduction

Dell Computer builds millions of computers each year, based on tens of thousands of configurations. Dell has been renowned for its Direct Model. Even prior to starting web PC sales in 1996, Dell sold computers through a direct sales force, catalogues, and telephone orders. With its business model, Dell has a huge inherent advantage, because it builds each and every computer in response to an order from an individual customer. Because Dell has no finished goods inventory to manage or dump, it can sell products with components purchased at more recent, lower costs (Lebovitz and Graban, 2001). The demand-driven manufacturing concept of Dell is based on a combination of factory responsiveness through lean manufacturing, supply chain and customer responsiveness, modular, configurable products and an organizational design for demand driven manufacturing.

Dell.com launched as a static web-page in 1994. By 1997 Dell was the first company to record a million dollars in online sales. In the last quarter of 2002, Dell.com logged a billion page views, a company first. About half of the company's revenue comes from the site, which means approximately $16 billion flowed through Dell.com in 2002.

Business Agility

Dell is highly dependent on the agility of its business partners. Dell makes extensive use of business partners to help serve its customers, especially as it has moved into producing servers and targeting the small and medium business market. Three functions - systems integration, service and repair, and consulting - all have to be located very close to the customer, as they involve direct contact with the customer. Dell partners with companies that can deliver these services globally - or at least regionally. Dell’s production network is changing. Whereas the network was previously located mainly in Asia, today it is increasingly regionalized in order to better target markets with a direct sales model and to respond rapidly to unanticipated changes in markets (Kraemer and Dedrick, 2001).

7 In preparing this case study the following references were used: Kraemer and Dedrick (2001), Maguire (2003).

How IT capabilities impact business agility

A key part of Dell's (online) success is its website, which offers customers the possibility to customize a combination of product, packaging and/or service components. Buyers can click through Dell.com and assemble a computer system and related services piece by piece. Based on this direct contact with customers, Dell knows exactly what its customers are ordering. Customers also provide continuous feedback on how the site is working, which is used to improve the user experience. To facilitate B2B sales, the Dell site offers each corporate customer an individualized interface. As part of the customer agility approach, Dell involves customers in product design, product configuration (via the online web shop) and service (via an extensive self-service web environment and user community portal).

Dell uses the Internet to provide a "constant and seamless flow of information among all different aspects of the company to drive the process." The company's back end is calibrated to respond so closely to orders from the front end that inventory is kept as low as only a four-day supply. Computer systems are built to order. Dell makes extensive use of outsourcing and partnering, but claims it will never outsource the final assembly of configure-to-order products. Connections with partners are via Dell's extranet and via structured message exchange based on EDI and real-time web based extranets. The business network architecture of Dell and some of the core IT capabilities are shown in Figure 3.3.

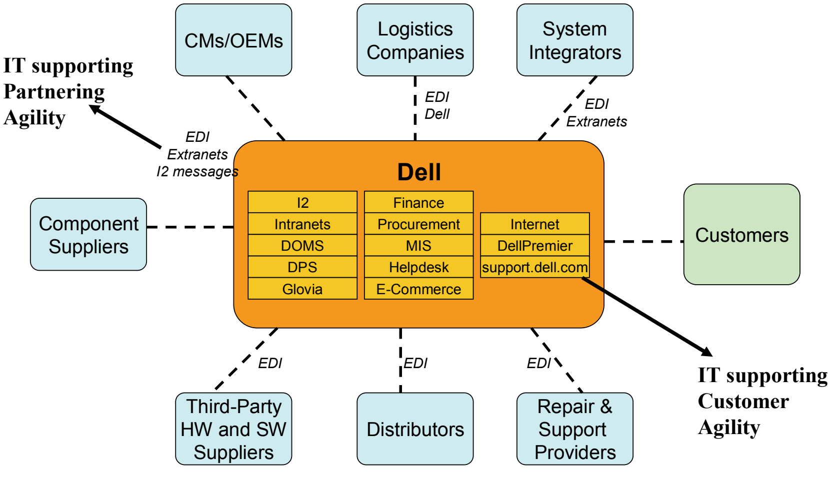

Figure 3.3 - Business network architecture of Dell and IT capabilities (source: adapted from Kraemer and Dedrick, 2001)

The software that Dell uses to create dynamic real-time links between customers, factories and suppliers create visibility and empower companies to respond directly to customer demand (Lebovitz and Graban, 2001). Dell uses dynamic yield-management methods to react to supply-demand imbalances. Dell can dynamically change prices for product options on its website to steer demand to components that are in stock but haven't been selling well (Kopzczak and Johnson, 2003).

Analysis

Dell is one of the best practice cases of companies that use IT agility to achieve superior performance. IT agility enables demand driven manufacturing, dynamic yield-management, customization and self-service. IT agility is based on high levels of data transparency and connectivity. This enables Dell's partnering and customer agility approach to respond quickly to uncertainties in customer demand.

3.6 Case 5: Zara apparel design: from concept to store within 4 weeks[8]

Introduction

Fashion supply systems are characterized by three critical lead-times: time-to-market (the time it takes to recognize a market opportunity, translate this into a product or service and bring it to the market), time-to-serve (the time it takes to capture a customer's order and deliver the product to the retail customer's satisfaction) and time-to-react (the time it takes to adjust the output of the business in response to volatile demand). All three of these factors require agility of the fashion supply network (Christopher *et al*., 2004). One of the best practices for agile supply chains in the fashion industry is Zara.

When Madonna gave a series of concerts in Spain, teenage girls were wearing at her last performance the outfit she wore for her first concert. When Spain's Crown Prince Felipe and Letizia Ortiz Rocasolano announced their engagement in 2003, the bride-to-be wore a stylish white pant suit. Within a few weeks, hundreds of European women were wearing something similar. All thanks to Zara, the pioneer of fast fashion[9]. In April 2006 Zara, owned by the Inditex Group, took the lead in fast fashion apparel away from giant Swedish retailer, Hennes & Mauritz (H&M), by posting $8.15 billion in sales in 2005, compared to H&M's $7.87 billion.

Zara introduces about 12,000 designs every year; the shelf life of each design is about four weeks. In January 2006, Zara had 853 stores, located across the world. These stores receive two deliveries from Zara's central distribution centre every week. The deliveries

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[8] In preparing this case study the following references were used: Christopher *et al*.(2004), Ferdows *et al*. (2005), Dymond (2007).
[9] Dymond (2007)

are customized in accordance with the data sent by them every day. Zara pioneers the concept of customized retailing. It takes Zara four weeks to go from identified consumer need and fashion concept to clothes in its store racks. Other traditional retailers struggle with inflexible IT and a restrictive 9-month design-to-delivery window. Most of Zara's inventory is sourced through this fast channel. Zara's production cycles are much faster than those of its nearest rival, Sweden's Hennes & Mauritz (H&M). While an entirely new Zara garment takes about four to five weeks from design to delivery; a new version of an existing model can be in the shops within two weeks. This process takes six to twelve months for an average retailer. In a typical year, Zara launches some 11,000 new items, compared with the 2,000-4,000 from companies like H&M or America's giant casual-fashion chain, Gap.

Business Agility

Some 300 designers work at the firm's head office in La Coruña in Galicia in northern Spain, producing 1000 new styles per month. They are in daily contact with store managers to discover bestselling items. The remaining inventory is sourced through low cost off shore manufacturers, similar to other retailers. Zara's fast products are deliberately created in small batches to avoid oversupply. Most lines are replaced quickly with yet more new designs rather than with more of the same. This in turn generates scarcity of supply. Shoppers cannot be sure that something that has caught their eye will appear in the store again—or can be found at another Zara store, even in the same city. This concept maintains a higher average selling price. All operations which enhance cost efficiency though economies of scale are conducted in-house. Examples are dyeing, cutting, labeling and packaging. All other manufacturing activities are completed by networks of more than 300 small subcontractors, each specializing in one particular part of the production process or garment type (Christopher *et al*., 2004).

The fast production chain at Zara removes a significant amount of risk that comes with fashion forecasting. So Zara finds itself in a position of not really having to bet on fashion so much as follow it. A 2004 Bain & Co. study found that fast-fashion outlets in Spain and Britain posted average double-digit sales growth, compared with 4% growth in overall retail sales in those countries.

Zara's single, centralized design and production centre is attached to Inditex (Zara's parent company) headquarters in La Coruna, Spain. It consists of three spacious halls—one for women's clothing lines, one for men's, and one for children's. Unlike most companies, which try to excise redundant labor to cut costs, Zara makes a point of running three parallel, but operationally distinct, product families. Accordingly, separate design, sales, procurement and production-planning staffs are dedicated to each clothing line. A store may receive three different calls from La Coruna in one week from a market specialist in each channel; a factory making shirts may deal simultaneously with two Zara managers, one for men's shirts and another for children's shirts. Though it's more expensive to operate three channels, the information flow for each channel is fast, direct, and unencumbered by problems in other channels—making the overall supply chain more responsive.

Once the team selects a prototype for production, the designers refine colors and textures on a computer-aided design system. If the item is to be made in one of Zara's factories, they transmit the specs directly to the relevant cutting machines and other systems in that factory. Bar codes track the cut pieces as they are converted into garments through the various steps involved in production (including sewing operations usually done by subcontractors), distribution, and delivery to the stores, where the communication cycle began.

How IT capabilities impact business agility

The constant flow of updated data mitigates the bullwhip effect—the tendency of supply chains (and all open-loop information systems) to amplify small disturbances. A small change in retail orders, for example, can result in wide fluctuations in factory orders after it's transmitted through wholesalers and distributors. In an industry that traditionally allows retailers to change a maximum of 20 percent of their orders once the season has started, Zara lets them adjust 40 percent to 50 percent. In this way, Zara avoids costly overproduction and the subsequent sales and discounting prevalent in the industry

Sensing for changes in fashion trends is a daily constant effort. All of Zara’s shops use point-of-sale terminals to report directly to La Coruña. On top of that, every evening, store managers consult a personal digital assistant to check what new designs are available and place their orders according to what they think will sell best to their customers. In this way, its store managers help shape designs. Zara does not employ star designers but often unknowns, many of whom are recruited directly from top design schools. Inditex is extremely clever in how it uses technology. The company keeps its technology simple—even a little old-fashioned—but as a result spends five to ten times less on information technology than its rivals. The IT systems of Zara support quick changes in product design, supplier selection, raw material acquisition, production and distribution schedules. Electronic Point Of Sale (EPOS) data and other information from all of the company’s stores and sites around the world provide direct (sensing) information from the market. Advanced IT couples Zara’s highly automated factories with a network of more than 300 small subcontractors. Zara’s "fast fashion" system depends on a constant exchange of information throughout every part of Zara's supply chain—from customers to store managers, from store managers to market specialists and designers, from designers to production staff, from buyers to subcontractors, from warehouse managers to distributors, and so on. Zara's organization, operational procedures, performance measures, and even its office layouts are all designed to make information transfer easy.

Analysis

Zara is a best practice case for business agility in the fashion industry. The supply chain of Zara is connected and integrated through shared information on real customer demand. Zara is market sensitive by using the daily POS data and capturing emerging trends. Zara focuses on its core competences and leverages the capabilities of partners acting in this respect as a network orchestrator. Responsiveness is engineered into the supply chain of Zara by aligning processes within the company and externally with upstream and downstream partners. This strategy yields collaborative product design by virtual project teams, co-managed inventory and electronic transactions (Christopher *et al*., 2004).

3.7 Case 6: Amsa: Sense and Respond in Waste Disposal[10]

Introduction

Amsa is a waste management company that offers many urban services in Milan, Italy as well as neighboring countries. These urban services include waste collection, cleaning services and treatments. The 2 million people who frequent Milan during the day make use of fast food restaurants, snack bars and canteens. In the evening, the city attracts people with its theatres, cinemas, restaurants, clubs and discotheques from all over the Lombardy region. It is very challenging to plan waste collection and street and pavement cleaning services in such a metropolis. In order to avoid traffic problems, the services are provided between 6 a.m and 11.30 a.m.: no later than 8 a.m. in the city centre and between 8 a.m. and 11.30 a.m. in the outer zones.

How IT capabilities impact business agility

All resources of Amsa are equipped with RFID and the location can be monitored via Global Positioning Systems and GPRS mobile communications between the resources and the central IT systems of Amsa. All the waste management vehicles must leave the downtown not later than 8 a.m. Amsa has developed a GIS system (Geographic Information System), based on a collection of digital photos certified by the municipal administrations and updated every three months. The system allows visualizing, amending and analyzing the information in the cartographic system of Milan and the neighboring towns; thereby promoting a focus on territory management. The GIS System is the core element for planning and gap analysis. As such it is one of the most important components of Amsa SIT (Sistema informativo territoriale – Territory Information System).

[10] In preparing this case study the following reference was used: Bielli (2008).

The Amsa SIT allows the geographical display of the items (specific, route and area items) which are the basic elements of all activities (baskets, dump containers, shafts, etc.). The specific items are regularly updated through Amsa operators' surveys on the territory, citizens' and municipalities' reports. Amsa SIT has the basic task of managing the Amsa geographical database, where basic cartographic and topically necessary information for effectiveness are stored. Then the planning data are sent to Gestione Operativa (GO _Management System), which is the application supporting Amsa’s core business. This system allows the management of the human and technical resources, which are required for the development of the statutory tasks and the services for payment, performed by Amsa. This system permits the display and support of all the business requirements and company activities including the planning and monitoring of all business activities. Also, this system provides the possibility to reconstruct an event history with proved evidence or to foresee the consequences of a former event.

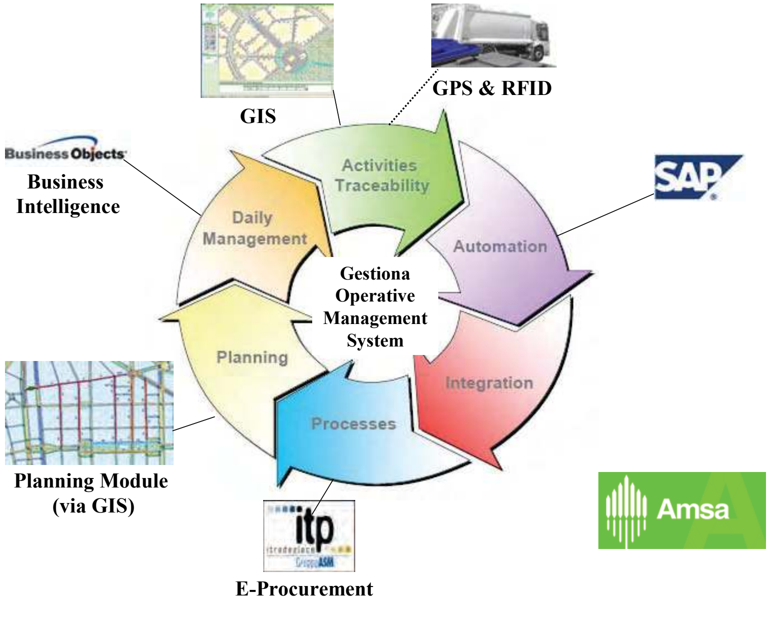

Figure 3.4 – Amsa Sense-Respond-Learn Cycle for managing waste disposal

With Amsa SIT it is possible to amend the daily work schedules to make up for unpredictable events, which cannot be managed by the monthly planning – such as staff absence, vehicles breakdown, infeasible work schedules due to road construction, strikes, labor shortages, or snow/rain emergencies. In order to optimize the collecting service, for vehicle availability, capacity, and environmental rules, the quantification of the rubbish from each geographical area is necessary. An average of about 350.000 movements (700.000 weighings) a year are recorded, distributed over five different weighing stations working 24 hours a day, 7 days a week. Amsa has developed the Co.R.Int.O. system, an application that is able to identify and automatically weigh vehicles (owned by Amsa or by a third party), to reduce times and to direct vehicles to the correct depot. The different applications and their role in the sense-respond-learn cycle are illustrated in Figure 3.4.

Once the work schedules have been fulfilled, the relevant data about the work executed on the territory are stored in a central system. This data includes the ID of the team, the Vehicle's TAG, the Exit time, the Return time, the Rubbish and weigh survey. Special typical data are required for some services (i.e. last stall removal time for market cleaning, the situation at 8 a.m. for the collecting services, etc.). Almost all data are recorded automatically among the management systems, without any manual input (i.e. in/out times, way-out survey, Ecos system weighing, 8 a.m. position by GPS, etc.). Comparing planning and surveys it is possible to verify possible anomalies and provide for adjustments. The analysis also provides alerts to any problem in planning: the iterative execution of this process makes the service planning dynamic and reduces the faulty service percentage, in order to obtain continuous improvement.

Analysis

Amsa has developed a true Sense-Respond-Learn cycle in its business processes and IT. Real-time data from its resources (and RFID) provide sensing information. Amsa tries to plan its operations as much as possible beforehand. Various systems are coupled to respond to unexpected events and re-adjust planning and operations quickly. Amsa employs learning capabilities by storing, analyzing and distributing historic (performance) data and decisions and connecting this as a feedback mechanism to improve and re-adjust future operations and planning.

3.8 Cross-case analysis

Table 3.1 provides a cross-case analysis. The cases are compared on business agility, the key sensing-, responding- and learning capabilities, the role of IT capabilities and the (impacts on) business performance. In cases 1 through 6, business agility performance is based on a combination of internal agility and external agility. External partnering agility requires high levels of information sharing among business partners to support sensing and responding (i.e. collaborative design and delivery). IT connectivity based on standards supports quick-connect and quick response to uncertain events. On top of that, in case 4 (Dell) customer agility is actively exploited.

Table 3.1 - Cross-case analysis

Charac-teristics	Cases 1.Wal-Mart	2.7-Eleven	3.MS Xbox	4.Dell	5.Zara	6.Amsa
Industry	Retail	Retail	Consumer Electronics	Computer industry	Fashion Retail	Waste Management
Business Strategy	Operational Excellence	Customer Intimacy	Product Leadership	Customer Intimacy	Customer Intimacy	Operational Excellence
Uncertain Event	Hurricane	Customer demand shifts	Exploiting new game console	Customer demand shifts	Customer demand shifts	Uncertainties in work planning
Business agility	Operational and partnering agility	Operational and partnering agility	Operational and partnering agility, importance of quick connect	Operational and partnering agility, customer agility (part of business model)	Operational and partnering agility	Operational agility
Sensing	IT-driven local (store level) sensing	IT-driven local (store level)sensing	Customer feedback	IT-driven sensing via web portal	IT-driven local (store level) sensing	IT-driven sensing
Responding	Efficient communication and visibility, support quick response	Localized response, locally empowered people via IT	Connecting and coupling capabilities of different partners	Advanced IT (dynamic yield management) and visibility to respond to customer demand, mobilize partners	Combining centralized production centre with large network of partners, collaborative design and fulfillment	Combine longer term planning with daily amendments, continuous visibility on resources
Learning	Importance of data warehouse to find cause-effect relationships and (changes in) demand	Intelligent IT-driven process for product replenishment and new product creation	Shared organizational memory IT among partners to improve product	Importance of data warehouse to track (changes in) demand patterns	Continuous fashion trend identification based on continuous sensing information	Use of surveys, organizational memory IT to store cause-effects of events and responses
IT infrastructure agility	High	High	High	High	High	High
Data Transparency	High	High	High	High	High	High
Sensing IT	P.O.S. data RFID, hurricane tracking SW	P.O.S. data RFID	P.O.S. data	Website P.O.S. data	P.O.S. data	RFID and GPS
Responding IT	Central IS	Central IS Mobile devices	Web based connectivity	Central IS Reconfigurable web shop	Central IS, Barcodes/ scanning	Central IS
Learning IT	Data Warehouse	Data Warehouse	Visibility portal	Data Warehouse	Data Warehouse	Data Warehouse
Key Performance Metric	Time to react	Time to react, Inventory turnover time	Time to Market	Time to serve	Time to Market, Time to serve	Time to adapt, Resource Utilization

With regards to IT agility, all the cases emphasize integrated and standardized information systems, a centralized governance (for instance on standards) and a centralization of core IS, with decentralized control and local empowerment to managers and employees. All cases mention high levels of data quality and transparency (visibility on (distributed) resources, goods and departments) to enable agility of the case companies as a whole. In most cases Point of Sale data, barcodes and RFID data provide detailed and real-time sensing information. All cases mention the use of centralized IS, which are capable of transforming large amounts of data into meaningful information (sense-making capability). Store terminals and handheld mobile devices are used as communication lines to disseminate this information quickly and empower local employees and managers with access to this intelligence.

The cases provide evidence that high levels of business agility performance have various effects on business performance. Responsive agile companies can quickly respond to unexpected events (case Wal-Mart and Amsa). Responsive and agile supply chains can shorten time to market for new products and services (case Microsoft and Zara). A demand driven agile supply chain can improve inventory turnover rates (case 7-eleven), reduce inventories in stock (case Zara), deploy dynamic revenue management and customize products and services (case Dell).

The cases are based on publicly available materials. This implies that they provide only a part of the picture and relatively little insight into the process of increasing business agility performance and the dilemmas in that respect for each firm. The case descriptions provide relatively little insight in SRL (mis)alignment and business-IT (mis)alignment. How does IT exactly support the sensing, responding and learning capabilities of businesses? Are there differences, dependent on the type of events that businesses need to respond to and which events require businesses to be agile? Another element that requires further research is an analysis of which capabilities enable business agility performance. Is agility of IT a sufficient factor to explain differences in business agility performance or are there other capabilities that can explain the differences in business agility performance levels. These issues will be discussed and researched in the empirical research in Chapters 4 to 6.

Chapter 4: Events requiring agility and implications for IT[11]

4.1 Introduction

It is often stated that a highly dynamic business environment requires businesses to adjust and act swiftly, in other words to be '*agile*' (Kenneth Preiss *et al*., 1996). As a result, the concept of *'agility'* is receiving more attention. Numerous books and articles have appeared attempting to define business agility. Academic literature and the professional press have discussed the topic in their recent reports on unexpected threats to businesses such as terrorism, unanticipated regulations or sudden market changes, and how agility can help to overcome these. Several Consultancies and IT vendors have made helping organizations to achieve agility part of their product offerings (e.g. IBM's 'On-Demand' vision and Hewlett-Packard's 'Adaptive Enterprise' strategy). They provide a variety of organizational and technical solutions that can help to achieve a proper level of agility for handling unexpected waves of change.

However, as was clearly shown in a panel discussion on "the agile enterprise" at MIT's CIO Summit (Schrage, 2004), there is by far no consensus as to what exactly agility is, nor on how one can assess and achieve agility. Very few studies have attempted to empirically study the need for agility. What are events requiring organizations to be agile and what is the relative importance of these events? Moreover, research assessing current perceptions on business agility performance is scarce. The few studies that we have identified with this aim are generally limited to one industry (usually manufacturing) and research method (mostly only a questionnaire or single case study). This chapter aims to define and empirically assess business agility and events that lead to a business agility need. To achieve this, we develop a frame work for analyzing agility and apply this framework in four distinct industries (mobile telecom, finance, utilities and logistics). To obtain both breadth and depth of the analysis, the data was collected using a comprehensive multiple method approach (multiple surveys and in-depth interviews).

Research questions and approach

This chapter investigates the following research questions:

1. Which events cause a business agility gap (i.e. for which events do firms perceive a deficiency in the required level of business agility performance)?

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[11] A previous version of this chapter has been published as Van Oosterhout, M., E. Waarts, J. van Hillegersberg (2006a). Change factors requiring agility and implications for IT. *European Journal of Information Systems, 15*(2), 132-145.

2. Which elements comprise the (transition towards) an agile IT architecture?

Based on the literature study in Chapter 2, a conceptual model is presented. The model distinguishes between events requiring agility, means (enablers) for business agility, (perceived) business agility performance and business agility gaps. A combination of quantitative (survey) and qualitative (interview) research methods was used to analyze the constructs in the framework. Based on this data, the most important events requiring business agility and the main business agility gaps are derived. Next, using qualitative data collected in interviews, we explore the means (enablers or hindrances) and best practices for creating agility in the organization and business network. We focus on the role of IT capabilities. Next, the implications of business agility for IT are discussed. Finally, main conclusions, implications, limitations and future research directions are provided.

4.2 Conceptual Model

In this section, the conceptual model and underlying elements for this study are explained. Building on the work by Sharifi and Zhang (1999) we constructed a model to analyze business agility in detail. Figure 4.1 shows the conceptual model.

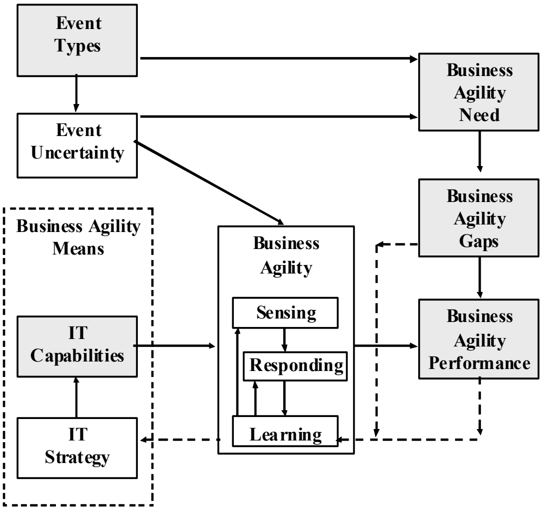

Figure 4.1 - Conceptual model for studying business agility

As part of the conceptual model, we study the following constructs:

Event types are *internal or external events that influence the need for business agility*. We labeled the different event types E1 to E7.

Business agility means are *the means (i.e. enablers) for an organization to enhance business agility*. We use Goldman's *et al*. (1991) four key agility dimensions to come up with a list of business agility means. In addition, in line with Yusuf *et al*. (2004), Van Hoek *et al*. (2001) and Mason-Jones and Towill (1999), we explicitly regard companies not as isolated entities, but as part of a business network that affects the level of agility of the individual company. A business network-wide strategy to cope with turbulence in the business environment is considered eminent for all stakeholders in the network. Therefore, we have added the business network dimension to the original model of Sharifi and Zhang (1999). Consistent with the literature review (Chapter 2), we built the conceptual model on a foundation of seven domains capable of enhancing business agility: business network governance (M1), business network architecture (M2), organizational governance (M3), organizational architecture (M4), IT capabilities (M5), people capabilities (M6) and organizational culture (M7).

Business agility performance refers to *the performance of an organization in swiftly changing businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events*.

A business agility gap is *the mismatch between the businesses agility need and the business agility performance*. A business agility gap can be either a lack of business agility performance or a surplus. Business agility gaps arise when the organization either has difficulty in meeting the required level of agility (for a specific event) in changing from one state to another in a timely and cost effective manner, or when there is a surplus of business agility performance.

Though the empirical study encompasses all four elements, in this chapter, we focus only on the identification of important events requiring agility and business agility gaps. We also briefly reflect on the implications for IT as a means to achieve agility at the end of this chapter.

4.3 Methodology

Research methods

The first phase of this research was a literature review and including significant internet research. The literature review focused on business agility, developments in four selected industries and agile IT. The literature review provided the necessary input to construct a survey. We used feedback of experts and two workshops to test and improve the survey. We did a cross-industry research study (as in Daniel and Wilson, 2003) with four industries as a basis for collecting empirical data. We selected a variety of methods for data gathering in order to provide a rich picture on the topic. On the one hand, we gathered quantitative data via online surveys. While on the other hand, in-depth qualitative data was gathered via interviews with executives and via workshops with business and IT managers representing the four industries that we studied. The results were validated by interviews with industry experts and a (shorter) quick-scan survey among managers.

Questionnaire

We constructed a questionnaire with 99 items across four parts covering the various elements of our research framework as discussed above. A copy of the full questionnaire can be obtained from the researchers. The survey was hosted on a website in order to gain a quick response. The digital output of the surveys was directly read into a database. Parts B (analysis of 65 external events) and C (analysis of 34 internal events) of the survey were built up dynamically. In Parts B and C various events requiring agility were presented to the respondent. To establish whether an event would demand change in a company on the short-term, each suggested event in the survey had to be scored on a 5-point Likert scale. A first question "*Probability that your organization has to change substantially due to a certain event*" assessed business agility need. If the score was '*high*' (score 4 or 5), a second question "*Indicate whether your organization can cope with this change easily*" assessed the perceived lack of business agility performance to cope with the event (also on a 5-point Likert scale). If this question was answered with '*(very) difficult'* (score 4 or 5), we designated this event as creating a business agility gap. In the final part of the questionnaire, Part D, open questions were generated addressing the top 10 business agility gaps. For each business agility gap the respondent was asked to elaborate on the bottleneck(s) and measures taken with regards to the gap. This way, the questionnaire generated both quantitative data on the business agility gaps as well as qualitative data on the means to achieve business agility. We did a cross-check on possible survey fatigue which might bias the results. We found no difference in the range of answers between the first half of the survey and the second half. We also checked the number of responses to individual items in the second half of the questionnaire and compared it with the first half. A few surveys were only partly filled in; these were taken out of the sample for analyses.

Selection of the industries analyzed

Our strategy was to focus on a limited set of industries as opposed to performing a large-scale survey across a broad spectrum of businesses. With this approach, far deeper insight can be gained regarding the factors that cause a need for agility and the difficulties firms have coping with these changes. In particular, four industries in the Dutch business community have been analyzed, each of which can be considered to be changing rapidly: logistics (logistics service providers), finance (retail banking), utilities (distribution and sales of energy) and mobile telecom (mobile telecom operators). These four highly dynamic industries were chosen, because they constitute an important segment of the total

Dutch business community and these industries are confronted with a wide variety of internal and external events that potentially lead to a need for business agility.

Data gathering and research sample

Within each industry, a sample of companies was made for the interviews with executives. The primary criterion used to select companies was their position in the market (top market share, considerable size). Within each company at least two executives were asked to fill out the survey. Their responses then served as the basis for the in-depth interviews. One interview was held to cover the marketing perspective of business agility (mainly with CEOs and Marketing executives) and one to cover the operations and IT perspective (mainly with COOs, CIOs and CTOs). The average duration of the interview was 90 to 120 minutes. The interviews primarily focused on the agility gaps found in the survey and the main agility issues found in the sector research. From each interview, minutes were taken and checked for accuracy with the interviewee. Table 4.1 provides an overview of the research sample for the case studies.

Table 4.1 - Research sample case studies

Industries	Finance	Mobile Telecom	Logistic Services	Utilities (energy)	Total
Number of companies interviewed	7	4	6	4	**21**
Number of respondents full survey	10	11	8	8	**37**
Number of interviews with executives	13	8	9	6	**36**
Expert interviews	3	3	3	2	**11**

Table 4.2 - Research sample quick-scan surveys

Industries	Respondents
Finance	67
Mobile Telecom	17
Logistic Service Providers	12
Utilities (energy)	6
Other (Industry, Government, Consumer Packaged Goods, ICT, Various)	79
Total	**181**

As a validation and expansion of the results found in the surveys and interviews, a shorter quick-scan version of the survey was sent out to a random sample of company contacts in different market segments (Table 4.2). We used SPSS to analyze the quantitative data and we organized expert sessions to extrapolate overall findings.

Analyzing the urgency of agility gaps – agility gap ratio

If businesses find it difficult to cope with certain events, which go beyond their normal level of flexibility, they are faced with a so-called agility gap. In order to analyze the urgency of the various events requiring agility, an agility gap ratio was calculated from the survey results. Events requiring agility that have a high probability of fundamental changes (score 4 or 5) and a high perceived lack of business agility performance (score 4 or 5) create an agility gap. In order to analyze the urgency of the various gaps we calculated an agility gap ratio by using the formula in Figure 4.2. The agility gap ratio has been scaled to a number between 0% (no gap at all) and 100% (largest gap possible). The higher the percentage, the more urgent the agility gap. In the visual representation of the agility gaps, the color *red* is used for the most urgent gaps (ratio >= 60%), *orange* for high urgency gaps (ratio > 50 % and < 60%) and *yellow* for gaps with a lower level of urgency (ratio > 40% and =< 50%).

$$AgilityGap\ Ratio_i = \left[4 * \left\{ \frac{\sum_{j=1}^{m} \left(\frac{\sum_{k=1}^{l} p_{ijk}}{l} \right)}{m} \right\} . \left\{ \frac{\sum_{q=1}^{t} \left(\frac{\sum_{r=1}^{s} e_{iqr}}{s} \right)}{t} \right\} \right] \%$$

Figure 4.2 – Agility Gap Ratio formula

The following list explains that notation pertaining to the agility gap ratio formula.

p_{ijk} The probability of a major business change, as indicated by respondent *k*, from company *j*, referring to event *i* (only non-blank answers have been taken into consideration)

e_{iqr} The perceived lack of business agility performance, as indicated by respondent *r*, from company *q*, referring to event *i* (only non-blank answers have been taken into consideration)

i The event requiring agility

j	The company of the respondent who responded to the survey
k	The individual respondent from company j
L	The number of respondents from company j
M	The number of responding companies
q	The company of the respondent who responded to the survey with one or more individual respondents scoring p_{ijk} (the probability of a major business change on event i) with a high score of 4 or 5 (only if the probability of a major business change scored 4 or 5 a question was posed to the respondent about the perceived lack of business agility performance to respond to the event)
r	The individual respondent from company q scoring p_{ijk} (the probability of a major business change on event i) with a high score of 4 or 5
S	The number of respondents from company q scoring p_{ijk} (the probability of a major business change on event i) with a high score of 4 or 5
T	The number of responding companies with an individual respondent scoring p_{ijk} (the probability of a major business change on event i) with a high score of 4 or 5 (only if the probability of a major business change scored 4 or 5 a question was posed to the respondent about the perceived lack of business agility performance to respond to the event) [in case of a high agility gap ratio $M = T$]

4.4 Findings

This chapter focuses on the assessment of the events leading to a business agility need and the business agility gaps. The results of the study reveal a number of events that generate *generic* business agility gaps, present in all industries under study, and a number of *industry* specific business agility gaps. Both types are reported below. The top fifteen generic business agility gaps (with their respective category number) – based on the average agility gap ratio - are shown in Figure 4.3. The values represent the average gap ratio per event over the four industries analyzed.

An emerging price war and the need for lower priced products & services are influencing all industries analyzed. Companies have many difficulties coping with the required changes. Lowering the prices requires another way of working and influences the way companies are structured to operate. The top 15 generic business agility gaps also indicate that most problems are found in the implementation of the required changes within an organization. To a large degree this can be explained by the existing legacy infrastructures (where increasingly more time and money are spent for maintenance and support). Figure

4.3 indicates that the need for agility is not just created by unpredictable events in the outside world. A lot of internal events (like mergers and acquisitions and changes in systems and procedures) require organizations to become more agile as well (3 out of 6 events in the top 6 are internal events, category E7).

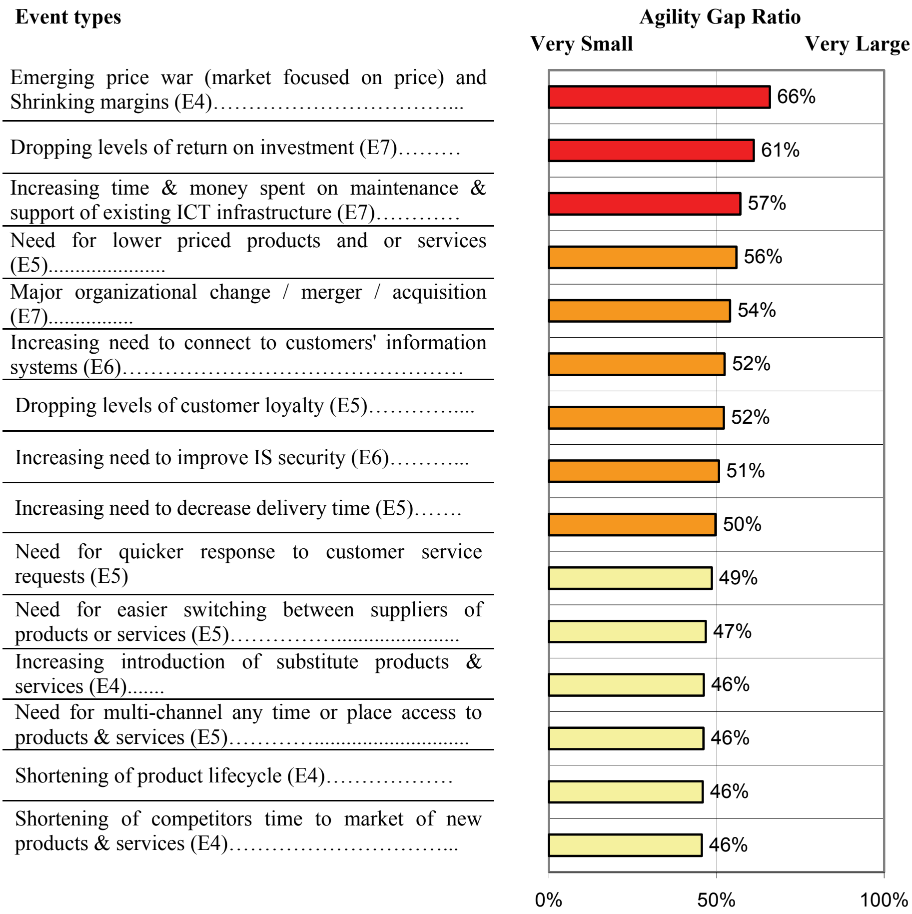

Figure 4.3 - Overall business agility gap top 15 (Source: Executive Survey)

Industry specific events requiring agility and gaps

When we compare the four different industries, we find many differences and a large variety of event types. The first observation is the fact that a price war is not the most dominant event requiring agility in the finance industry (Figure 4.4).

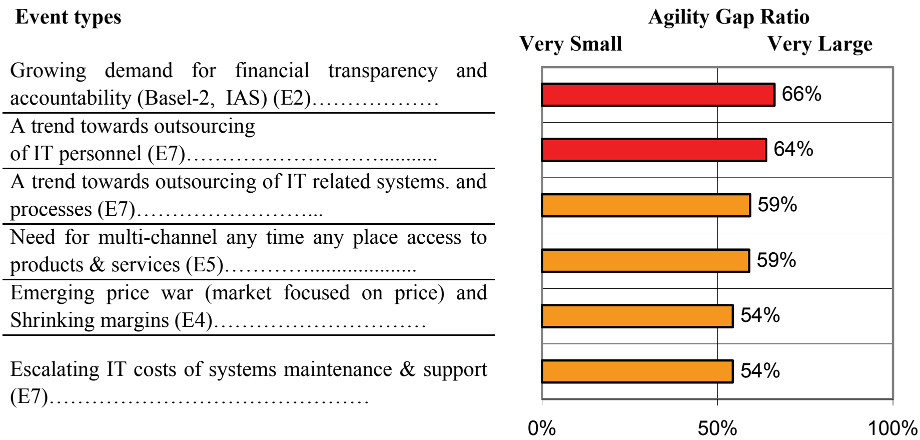

Figure 4.4 - Overview of most urgent business agility gaps in Finance

The financial industry consistently needs to react quickly to several high impact regulations, for which the actual specifications and requirements are not always available in a timely fashion.

"New legislation (e.g. a standard Health Insurance) is being created by the government. Due to our political system this legalization takes a long time before it is settled to the final laws. Mostly there is hardly any time to implement these changes. We try to reduce complexity by mapping all regulations on the company and combine the effort for compliancy" (manager Health Insurance company).

"Old information needs to be kept in stock due to legal rules. Especially if this information is embedded in legacy systems, these systems need to remain operational depending on legal requirements" (manager Bank)

Another gap occurs in meeting the need for multi-channel access. These gaps seem very much related to other gaps in the red and orange zone. The new regulatory and multi-channel demands put pressure on the huge legacy systems base. A manager working for an international bank explained the difficulties in customization and multi-channeling:

"Customers require more customized products and services. However, customer information cannot be aggregated due to local client id's that cannot be mapped onto one. This must be solved before extending it with more complex constructs. A problem in responding to customer service requests is fragmented information. We are not able to link information on a specific client to that client. Information is stuck in country/product information silos, with local client IDs. Also transactions cannot be tracked through different systems. We are now developing a reference model and introducing global IDs for clients, products and transactions. Without these global identifiers information cannot be linked and can only be incomplete and of low quality" (International Bank).

Attempts to handle these requirements increase costs. The apparent solution to outsource resources and personnel is complex and creates more gaps in dealing with this radical change in the organization.

In contrast, the logistics industry (Figure 4.5) is confronted with a high number of 'high urgency' agility gaps.

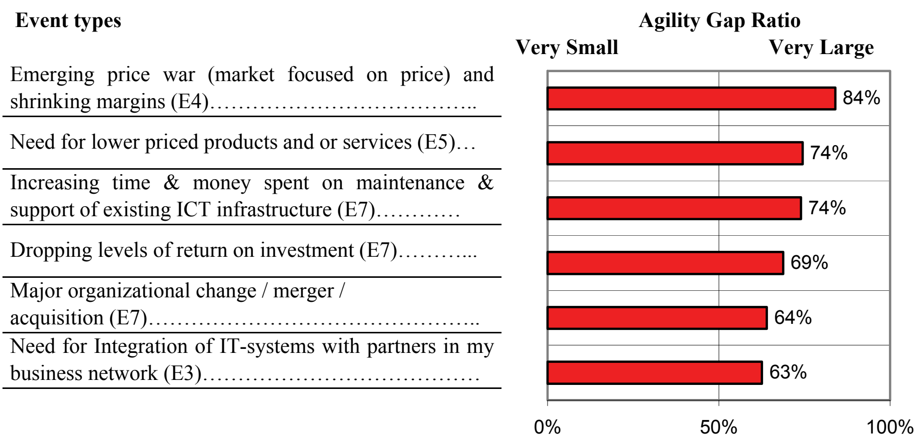

Figure 4.5 - Overview of most urgent business agility gaps in Logistics

Due to fierce competition in the commodity services, prices are under pressure. The consolidation trend has resulted in a large number of mergers and acquisitions. Economies of scale have been achieved, but also often a patchwork of IT and organizational architectures. As a result of the outsourcing trend, logistics service providers have often 'inherited' customers' logistics systems, or have to integrate tightly to these. As a manager describes:

"Like a city, existing information systems have grown over a long period of time. Time and money spent on maintenance grew at an even faster pace. A major part of development budgets is needed for maintenance leaving (too) little funding for innovations. A real 'Catch 22'" (manager logistics service provider).

Finally, the need for chain-wide tracking and tracing also requires integration to partners' information systems. Jointly, these developments have resulted in complex and heterogeneous IT architectures that need to be maintained and changed. As a result, new products, services and regulations require many resources in order to be implemented. Note that the gaps related to price pressure, systems integration and systems adaptation are severe (> 70%).

Also facing competitive pricing events, the main gaps for the mobile telecom industry (Figure 4.6) originate from intensified competition.

Event types

Dropping levels of return on investment (E7)……

Emerging price war (market focused on price) and shrinking margins (E4)…………………………

Shortening of competitors time to market of new products & services (E4)…………………………

Consolidation of competitors / merger or takeover from within the branch (E3)……………………

Accelerating rate of innovation of product technology (E6)…………………………………..

Increasing need to connect to customers' information systems (E6)…………………………

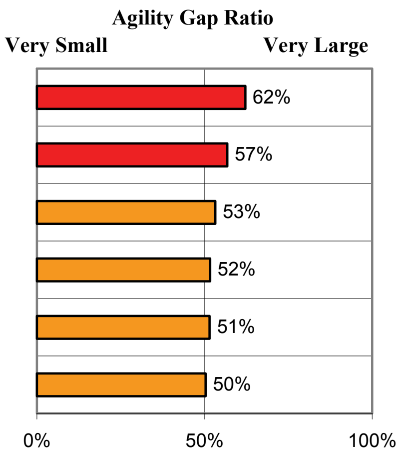

Figure 4.6 - Overview of most urgent business agility gaps in Mobile Telecom

New services have resulted in customized products and services that need to be put on the market in ever shorter time. The core systems to handle the variety of products cannot be adjusted quickly enough to implement the new requirements. Note that the gaps are not very severe (< 70%) and that potentially disruptive innovations such as Wireless (WIFI) and IP telephony are only causing moderate gaps. It seems that the mobile telecom industry has over time developed best practices to cope with the rapid technological change.

Similar to the financial industry, the utilities industry (Figure 4.7) is confronted with a high number of 'high urgency' agility gaps related to regulatory changes. In particular, the regulation that enforced an open utilities market has had a large affect on agility and perceptions of agility. Although this did not come as a surprise, still the impact may have been underestimated.

"We know deregulation is coming and how it will change our market; however we do not exactly know how and when and which exact changes are required in our operations. Therefore we need agility in our processes and systems to be able to move quickly (Manager Energy Company)."

The new phenomenon of having to worry about dropping levels of customer loyalty & customer satisfaction and a potential price war did create large gaps. IT infrastructures were never designed for processes needed in an open market. The organizational culture was more directed towards product quality than customer service.

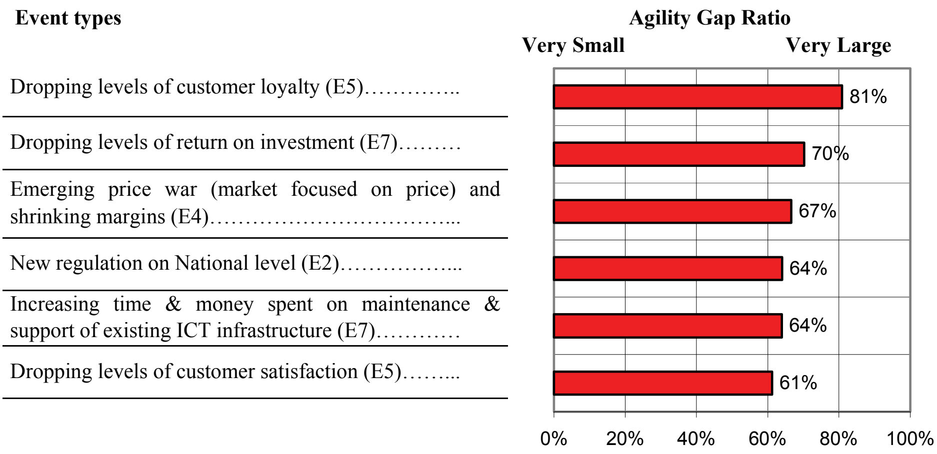

Figure 4.7 - Overview of most urgent business agility gaps in Utilities (Energy)

4.5 Business Agility and the role of IT

As shown in the research model (Figure 4.1), IT can be both an event that requires business agility and a means (enabler or hindrance) for business agility. Dynamics in the development of IT – especially the introduction of e-mail, the World Wide Web and mobile communications - have raised expectations from customers and therefore contributed to increased clock-speed in various industries. A respondent in the survey nicely summarized the challenges this poses for firms with regards to their level of agility:

"People always want things to be as fast as the fastest response they had yesterday. They don't accept the average response of today to be equal (or longer) than the fastest response yesterday. With World Wide Web competition you can gain or lose a customer within 3 clicks" (respondent to survey)

This section discusses the relationship between business agility and Information Technology (IT). The analysis presented here is based on the interviews with executives and remarks given by respondents to the open questions in the questionnaire. Overall, the respondents confirmed that IT can both inhibit agility, as well as be a means to achieve agility. These results are in line with the analysis of Attaran (2004) on a number of business process redesign cases, where '*IT was the biggest barrier to rapid and radical change, because radical change required IS redesign'* Often, within the same company, examples of both cases could be given. We will first elaborate on typical examples of IT as hindrance for agility. Next, we present some best practices of IT as an agility enabler. Finally, we point out some recent insights, spanning all industries, on how one can achieve an agile IT architecture that is well aligned to business agility requirements.

IT as a hindrance for agility

Most enterprises we analyzed are entangled in large, complex information systems with hard coded embedded business processes and complex webs of links between applications, which often are organized into separate silo's of technology from different vendors. Changing requirements takes a long time to implement and insufficient (IT) budget disallows investing in innovation. Over the past ten years companies have invested a lot of money in solving the millennium problem and the Euro conversion. Less money has been invested in new IT platforms as a basis and enabler for change. In practice, companies and customers are frequently constrained by the limitations of the IT system.

Due to the existence of inflexible legacy IT systems, an increasing amount of time and money needs to be spent on systems maintenance and support (resulting in high agility gaps within finance, logistics and utilities). Several agility gaps can be attributed directly to rigid IT architectures. For example, an executive of a major bank commented:

"International Financial Reporting Standards (IFRS) is not an accounting problem but an IT-problem. Existing and current systems do not necessarily supply the information we need, when we need it and in the format or quality we need. Providing detailed risk insight for many customers is impossible without changing the IT-system".

Surprisingly, for another major bank, the IT architecture created in recent years caused more severe problems than the systems from the 1980's and 1990's. He commented:

"Our key concerns are not our back-office systems that were created twenty years ago when technologies were relatively stable. Our main worries are maintaining and changing the recent front office systems implemented to support e-commerce and multi-channel customer access. The rich variety of technologies and tools used, many of which are no longer supported, create enormous complexity".

Managers stress that the unpredictability of the timing and impact of regulations especially demands agility in IT architectures. Although IT architectures may have been designed to offer certain flexibility, e.g. coping with foreseeable changes in business processes, the new requirements resulting from regulations have had a drastic impact. One executive remarked:

"Basel 2 demands lots of changes in our legacy IT-systems to be applied and tested. Because of this, our most qualified people are now not able to work on more commercially necessary projects".

An energy industry expert comments:

"Energy companies used to have integrated systems that have grown over the years to support most of their business functions. Quite suddenly, these systems now have to be split up vertically, as new regulation requires Chinese walls to be put up between the Retail, Production and metering function'. While the split up is being realized, at the same time, mergers in the energy industry call for horizontal integration".

Such simultaneous cutting up and merging or replacing parts of legacy software systems results in unprecedented challenges to energy companies. Moreover, companies in the energy industry had to engage in marketing and the required supporting customer relationship management systems. As one IT manager comments:

"our inexperience with marketing our products and the use of CRM systems makes these already complex CRM implementations even more challenging for us".

The IT departments within these companies were used to a relatively stable environment and responded to the new requirements by hiring large numbers of consultants. However, the transition to a project organization, coupled with the large differences in culture of the internal and external employees, caused considerable difficulties in many cases.

The financial industry is recognized as being among the first to have introduced comprehensive software systems in the nineteen-seventies and -eighties. In many organizations these traditional architectures now hinder a transition to architectures that are more process-centric and customer-centric, while supporting multiple communication channels such as web-browsers and mobile phones. As the CIO of a large bank explains:

"*We have recently had three large and critical systems development projects that have put a high strain on the organization. One aimed at bringing mobile banking to the customers, another was* *concerned with the launch of internet banking, and a third was an organization-wide roll out of a CRM package. In each of these, we have faced budget and schedule overruns, performance and scalability problems, etc. that could be largely attributed to the complexity of connecting these systems to our backend legacy systems. As a result our IT organization is now paralyzed, and nobody seems to be willing to take on any new large scale projects".*

The complexity and sometimes outdated architecture of legacy systems may also explain why process and personnel outsourcing are causing gaps, especially in the financial industry. One IT director commented on the challenges met when outsourcing a system offshore:

"We found that software code was insufficiently documented, and the documentation available was often outdated and written in the Dutch language. So we decided to send personnel offshore to sit next to the new system developers in what we call knowledge transfer sessions. Local personnel spent weeks or even months at the offshore site. Keeping our local IT people motivated in these operations has proven to be a difficult task".

Finally, traditional IT architectures have usually been designed to primarily support internal business processes. Creating easy and quick connections to external systems was never the original design intention; as such doing so now is not a straightforward process. Although advanced enterprise integration platforms have become available, the lack of simple interfacing capabilities of the existing legacy systems coupled with a lack of personnel experienced in cross organizational integration projects makes this business agility requirement hard to achieve.

Overall, many respondents found insufficient alignment between business and IT and a lack of central orchestration important hindrances for agility. Also people tend to forget the basic rule to first (re)organize and then automate.

"We need to translate customer requirements into information first, then extend our reference models. Only then we should look for technology to implement the requirements. However, still that's not what's happening. Again and again technology driven initiatives are started and fail. There seems to be rather little learning" (respondent survey).

"Last 7 years a lot of new technology has been introduced, seemingly for technologies sake and not for introducing quality IT solutions. A lot of hype on CRM, WEB, Services, Integration but very little content. Decisions makers trust technology to solve their business problems" (respondent to survey).

IT as an enabler for agility

In the study we also found cases where the highly ranked gaps did not occur. Often, the respondents pointed to an agile process and information system architecture as an important factor in preventing agility gaps. For example, the COO and CIO of a telecom company explained to us that their relatively simple IT architecture had enabled them to deal with the ongoing price-war and the need to quickly implement new requirements.

"In telecom, as competition for big contracts is fierce, it's important to be able to quickly implement new contracts into your billing system. After having put great effort into setting-up a transparent and responsive IT-organization, simplifying and standardizing interfaces, and reducing the number of systems, we are now able to do this, I believe, faster than our competitors".

A national branch of a foreign bank had the advantage of entering the Dutch market without carrying a heavy legacy. In setting up their processes and IT architecture, they focused on an efficient front-office that could easily interface to external administration offices. Their CEO explains:

"We specialize in loans and mortgages that we sell against very competitive interest rates. We can do this because we have a very lean organization. All mortgage contract administration is done by an external service provider to which we have interfaced our processes and systems".

Another organization we analyzed is a relatively independent subsidiary of a multi-national bank. From the decision to enter the market until the first accounts were opened, time to market was only seven months and €6 million in expenses. The IT architecture is based on the use of component technologies and a five tier layered architecture. Customers can open an account online in just five minutes. The bank uses an integrated business and technology approach, with a centrally orchestrated structure. One single department is in charge of IT strategy, operations management, security, compliance and governance. The infrastructure has been designed around the customer, utilizing a centralized database that supports all distribution channels. Sensing capabilities are implemented via risk and performance indicators for monitoring and improving systems and business solutions. Low operating costs and increased agility (short time-to-market) have given them significant competitive advantage and growth. Customer agility is one of the key enablers for the success of this organization, as the IT manager explains:

"Multi-channel access to products and services requires a 7x24 hour service organization with skilled agents. We use self service web applications to facilitate our customer requirements" (manager finance firm).

A multi-national logistics company has utilized its European expansion and the availability of low cost high bandwidth network connections to set-up and connect processes with IT

Competency Centers. For example, one national site specializes in warehouse management and offers the functionality as services on the European network to other sites. Another site focuses on fleet management etc. Using this strategy, the CIO has realized several advantages:

"W*e were able to reduce the number of different and redundant systems within the company, bundle expertise in competency centers, and operate in a more uniform way across Europe towards the customer"*.

The transition to an agile IT architecture

The examples of IT as an enabler and hindrance of agility, stress the need for organizations to implement an agile IT and process architecture in areas where business agility is required. Indeed, several respondents in this study were active on migrating from levels one and two of enterprise architecture maturity to higher levels of enterprise architecture maturity (Ross *et al*., 2006) supporting higher levels of agility. But, what exactly is an agile IT architecture and how does one complete the transition? Several authors have described properties of agile IT architectures and the factors that drive the transition (Evgeniou, 2002; Konsynski and Tinana, 2004; Ross *et al*., 2006).

Agile IT architectures are characterized by highly standardized IT components with network connectivity and hardware compatibility (Duncan, 1995; Byrd and Turner, 2000; Ross, 2003; Konsynski and Tinana, 2004). An agile architecture is based on simplification with reconfigurable modular components. This facilitates easy modifications and scalability. High levels of data quality and data sharing are an important component of agile IT architectures (Christopher, 2000; Christopher and Towill, 2000; McCoy and Plummer, 2006). An agile IT architecture can be analyzed on four different levels of the business network – from the lowest to the top level: hardware and systems software infrastructure, application software, management of an individual business and dynamic control and governance of the business network (Vervest *et al*., 2005). All of these levels need to support integration and quick-connect and quick-disconnect capabilities to external partners (Sanchez, 1995; Goldman *et al*., 1995). Agile IT architectures support a firm's sensing, responding and learning, which are key dimensions of business agility (Dove, 2001).

On the lower infrastructure level, agility can be incorporated as the basis for the concept of organic IT (Gillett, 2002). IBM uses this concept in their *on-demand* strategy and HP in its *Adaptive Enterprise* strategy. By treating IT infrastructure like a utility, both storage capacity (via virtualization) as well as processor capacity (e.g. on the basis of grid computing) can be instantly (re)scaled, according to changes in demand. Via control tools, sensing is achieved (due to increased visibility from drill-down and exception reporting), while respond capabilities are implemented by being able to quickly reconfigure the IT infrastructure (e.g. in case of capacity problems in a certain part of the physical network) through a number of relations in the control dashboards. In the mobile telecom industry operators can quickly change the routing of data, if there are problems in a certain part of their network infrastructure.

At the organizational level, when thinking of agility, one should not think of complete freedom to decentralized departments and business units to build or buy whatever system they need, nor of a rigid centralized system and inflexible IT-department. Rather, agile IT architectures are designed for controlled change by using standard IT components in a service oriented architecture. An agile IT architecture supports (the migration from batch processing to) event-driven processing. Agile software development methodologies (like extreme programming) are used for construction of new IS.

On the application, management and business network levels the concept of the enterprise service bus (ESB), the next generation of enterprise application integration (EAI), provides a framework for agile IT architectures. Given the existence of legacy systems and a variety of standards and protocols, various types of ESB middleware are needed as part of an agile IT architecture. Basic building blocks of the ESB are a service-oriented architecture with a high level of security (via digital signatures and encryption) and replaceable modular components. Interoperability is achieved via the usage of standards and open protocols and various types of ESB middleware and adapters for legacy systems.

The move towards Service-Oriented Architectures (SOA) and the use of tools for business process orchestration and business activity monitoring promise higher levels of IT agility to support a firm's sensing and responding capabilities (Welke *et al*., 2007). Business Activity Monitoring (BAM) solutions are *real-time control systems that capture events in real-time from multiple, heterogeneous sources and selectively raise alerts within limited time-windows of opportunity* (Chandy and McGoveran, 2004). BAM is one of the critical elements of a larger technology foundation that incorporates Business Process Management (BPM), business analytics, Service-Oriented Architectures (SOAs), and Event-Driven Architectures (EDAs). Via BPM tools, business process design and business rules can be codified. BAM provides the critical junction at which events, services, and processes are linked with rules, notifications, and people (Deeb and Knifsend, 2005). BAM solutions are highly adaptable and do not affect the performance of the underlying transactional (legacy) systems. BAM solutions support sensing (acquiring data from multiple heterogeneous data sources), sense-making (processing and interrelating events, identifying exceptions based on pre-defined event-based business rules) and response implementation (by creating alerts and sending these to responsible people to trigger an action). Welke *et al*. (2007) analyzed a number of case studies in the airline industry, where service orientation and the use of business activity monitoring tools led to better regulatory compliance, reduction of operational costs, greater management visibility on operations and improved customer service.

So far only a few researchers have analyzed if and how SOA can be used to improve IT integration and business agility. Oh *et al*. (2007) analyzed the impact of SOA and general IT capabilities (IT management skills and IT technical skills) on organizational integration, causal ambiguity and sustained competitive advantage. Their results show that SOA can provide enhanced agility for integration of intra-firm processes (internal organizational integration) and inter-firm processes (external organizational integration). IT capabilities have a greater effect on internal organizational integration. A significant relationship was found between internal organizational integration, causal ambiguity and sustained competitive advantage. The lack of standards is, however, hindering widespread adoption of SOA (Feig, 2008). More empirical research is required to investigate whether the deployment of SOA indeed increases agility, or whether such architectures create new levels of complexity (Rettig, 2007). In this respect a difference should be made between SOA on top of existing legacy systems versus SOA as the basis of a newly constructed IT architecture. In the case that SOA is used as a middleware layer on top of existing legacy systems, connectivity increases. However, such architectures do not comply with all the design guidelines of a truly agile IT architecture. Therefore blended IT architectures are not as agile as completely services-based SOA architectures. Future research on SOA as enabler for business agility can build upon recent work of Hirschheim *et al*. (2010) who develop a five stage maturity model for Service Oriented Architecture.

Although the building blocks of agile IT architectures and the examples described here may sound appealing at the conceptual level, the road to achieving such agile architectures is filled with hurdles. People learn, work with, and master specific applications making them reluctant to give up ownership.

"Each kingdom wants to have its own IT assets" (respondent to survey).

So far, most companies have no or just a limited inter-firm or network perspective. To our surprise, the need for quick-connect capabilities within a business network was only expressed by a few executives in our study. Most of them were primarily focusing on the optimization of their internal (IT)-operations. For new entrants, agile IT architectures are often within reach. However, for large established corporations, transforming to an agile IT architecture is usually more challenging. The transition towards agile service-based architectures should thus not be underestimated, and expectations and planning should be carefully managed.

4.6 Conclusions and recommendations

Methodological conclusions and reflection

The overall research objective of this chapter was to establish a framework to analyze events requiring business agility and to measure the gap between current business agility performance and the business agility needed in a variety of industries.

Thus far, there has been limited attention in the literature on the establishment of measurement frameworks for business agility (Dove, 2001; Swafford *et al*., 2006; Overby *et al*., 2006). We have chosen to develop a new theoretical framework based on a broad review of the literature and a multi-method survey approach. The survey made use of structured questionnaires and interviews to cover all important aspects of business agility. An agility gap ratio was used to assess the urgency of the various gaps. Using this methodology, we measured the perception of the respondents with regards to the need for business agility and their perceived business agility performance; we did not measure business agility performance on the basis of objective metrics. Though far from trivial, future research could focus on the development and application of a set of such metrics.

We analyzed enablers and hindrances for business agility via interviews and qualitative free-text remarks of respondents to the questionnaires. This provided interesting qualitative insight into the enablers and barriers for achieving increased business agility. We did not, however, construct a set of measures to objectively measure whether certain capabilities were (perceived to be) a hindrance or enabler for business agility.

As stated by Whadhwa and Rao (2003) the boundaries between flexibility and agility are blurred. We have made a first attempt to develop a questionnaire to assess the importance of events requiring agility in different business segments. Respondents were asked about the predictability of each event type. One could argue that a more stringent difference should be made between events requiring more flexibility versus events requiring more agility. On the other hand, although the probability of an event might be high, in most cases, the predictability of necessary changes in the business is quite low. For instance the probability of expected changes due to government regulation in the energy industry was high, but the predictability of the timing and details regarding the necessary changes in the business and organizational systems and processes was rather low. Therefore deregulation as an event caused a high need for agility. Given the difficulty encountered in coping with the change, a business agility gap was realized.

Substantive conclusions

What are the (main) gaps between the current business agility performance and the need for business agility in the four industries? Based on the survey and interviews with executives we came up with rankings of business agility gaps across the four industries analyzed. The results show a number of gaps are present in all four industries. While we found a lot of variety between the four industries analyzed, we did note that the emerging price war and the need for lower prices products & services combined with fast changing customer requests is dramatically influencing all industries analyzed. Companies feel severe difficulties in coping with the required changes. In many cases it requires a totally different way of organizing the company and its business network. Companies are very worried about the pace at which solutions can be implemented. To a large degree this can be explained by the existing organizational structures, cultures and legacy infrastructures. Executives, in all industries researched, feel the unpredictability of government regulation and government measures forcing them to make their processes and systems more agile. Examples of such regulations are demands for more financial *transparency* and *accountability* (e.g. Basel 2, International Financial Reporting Standards [IFRS] and International Accounting Standards [IAS]), deregulation measures in the utilities industry and EU Food Law regulations, including clear requirements for traceability in the logistics and retail industry. The lack of implementation details and timing makes it necessary to implement the required changes in a short time-frame. The results also indicate that the need for agility is not just created by unpredictable events in the outside world; often internal events (like mergers and acquisitions and changes in systems and procedures) require organizations to become more agile as well. This is reflected in the relatively large number of events in category E7, which scored relatively high as an agility gap. This finding is similar to Hackbarth and Kettinger (2004), who found an inability of firms in becoming net-enabled due to internal factors.

A second research question concerned the elements that comprise the (transition towards) an agile IT architecture. Agile IT architectures are characterized by highly standardized IT components with network connectivity and hardware compatibility. An agile architecture is based on simplification with reconfigurable and modular components. This facilitates easy modifications and scalability. High levels of data quality and data sharing are important components of agile IT architectures. The technology foundation that provides the basis for an agile IT architecture incorporates Business Process Management (BPM), business analytics, Service-Oriented Architectures (SOAs), and Event-Driven Architectures (EDAs) (Welke *et al*., 2007).

Further research

This research was conducted in the period of January 2004 through August 2004. The research focused on four industries in the Netherlands. In order to gain more insight into the dynamics of business agility and the role of IT we have three recommendations for further research. First, we recommend further refinement of the assessment instrument, taking causalities between relations into account, while measuring both events that require agility and the means that enable agility. We would like to measure the actual effects of specific agility means on the business agility performance of individual organizations and their business network. This would generate the necessary empirical evidence to create a benchmark as part of an agility barometer, by which organizations could compare their agility score with similar organizations in an industry.

Secondly we recommend broadening the scope of the current research project to other countries. We expect that cultural and geographical differences influence the need for agility and the business agility performance. An international benchmark would make it possible to compare the level of business agility and the competitive position of the Dutch business community with business communities in other countries.

Finally, more research is needed on the effects of agile IT architectures on business agility performance and the agility performance of the business network as a unit of analysis. The first examples of smart and agile business networks are appearing in practice (Vervest *et al*., 2005), but more (empirical) research is needed to determine the effects and impact of agile IT architectures, given the type of events requiring agility in a specific industry.

Chapter 5: Need, performance and alignment with IT-strategies[12]

5.1 Introduction

The concept of agility originated in the USA within manufacturing at the end of the eighties and in the early nineties. Agile Manufacturing was first introduced with the publication of a report entitled *21st Century Manufacturing Enterprise Strategy* (Goldman *et al*., 1991). This was followed by a series of publications on agile manufacturing and agile corporations (Kidd, 1994; Kidd, 1995; Goldman *et al*., 1995; Dove, 2001). The concept was then extended to supply chains and business networks (Christopher, 1992; Mason-Jones and Towill, 1999; Van Hoek *et al*., 2001; Swafford, 2003; Yusuf *et al*., 2004).

Despite the history of the concept, there is, as of yet, no consensus regarding what exactly agility is. Nor is there consensus on how one could assess and achieve agility (Schrage, 2004). Very few studies have attempted to empirically study the need for agility, the perceived performance and the business agility gaps. In this chapter we study events that lead to a need for business agility with (in)direct implications for IT. As a result, we suggest a number of possible IT strategies for enhancing business agility. The results are based on a survey among 110 respondents and case studies in 35 public and private organizations.

5.2 Conceptual model

Building on the literature study in Chapter 2 we constructed a conceptual model to analyze business agility in detail (see Figure 5.1). The focus of study for this chapter is highlighted.

The starting point for the conceptual model are the external and internal events that may create a need for business agility (based on Sharifi and Zhang, 1999). In this chapter we focus on the analysis of those events, where of the response required by the organization is related, directly or indirectly, to the organization's IT capability.[13]

An organization's business agility performance (in short BAP) is determined by its business agility means. Business agility means are the means by which a business can

[12] A previous version of this chapter was published as a book chapter: Van Oosterhout, M., E. Waarts, E. van Heck, J. van Hillegersberg (2006b). Business agility: need, readiness and alignment with IT-strategies. In K. C. Desouza (Ed.), *Agile Information Systems: Conceptualization, Construction and Management* (pp. 52-69): Butterworth-Heinemann.

[13] We would expect industry sector characteristics will influence the business agility need for certain events, however this effect was not measured in our research.

enhance its business agility. Business agility means can be categorized based on the work of Sambamurthy *et al*. (2003) and Weill *et al*. (2002). The business agility means are the reasons behind the existence or non-existence of business agility gaps. If there is a mismatch between the businesses agility need and the business agility performance there is a business agility gap (in short BAG). This has implications for the IT strategy.

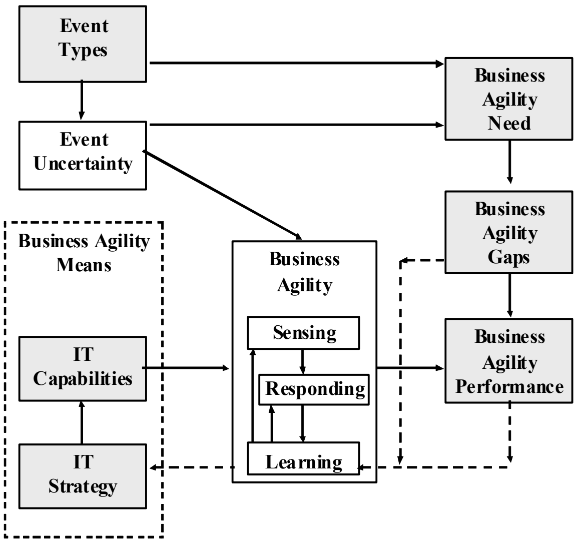

Figure 5.1 - Conceptual model

In this chapter we report on the perceived business agility need (in short BAN) and the perceived business agility performance (BAP) for external and internal events which are directly or indirectly related to the IT capabilities of the organization. We also discuss possible IT strategies to close the business agility gap (BAG). This chapter analyses the following research questions:

1. Which events cause a business agility gap (i.e. for which events do firms perceive a deficiency in the required level of business agility performance) and is there a difference between different industries?

2. What IT strategies exist for enhancing business agility?

5.3 Methodology

Based on the literature review we constructed a questionnaire. We used feedback from experts and two workshops to test and improve the questionnaire. We chose to use multiple methods for data gathering in order to provide a rich description on the topic. We have gathered quantitative data via an online questionnaire (110 respondents). This was complemented with in-depth qualitative data, gathered via interviews with fifty managers and via workshops with business and IT managers representing the industries that we studied. The results were validated by interviews with fourteen industry experts.

Based on a literature review and workshops with experts we constructed a questionnaire[14] containing twenty-seven events, covering the three agility dimensions of our framework: events requiring operational agility, events requiring customer agility and events requiring partnering agility. An overview of these events can be found in Table 5.1. Each event in the survey was scored on a 5-point Likert scale. We used the question '*indicate the probability that your organization has to change substantially outside the normal level of flexibility*' to assess the perceived business agility need (BAN). If the 'perceived BAN' due to a certain event was 'high' (score 4 or 5), a second question was posed regarding the perceived BAP (also on a 5-point Likert scale). We used the question '*indicate whether your organization can cope with this change easily*' and rescaled the answers, where 1 refers to very low perceived BAP (i.e. very difficult to cope with the change) and 5 refers to very high perceived BAP (i.e. very easy to cope with the change). Contrary to the previous Chapter 4, in this study we measured the BAG as BAN minus BAP. This would facilitate a better analysis of possible surplus or lack of agility.

In the next part of the questionnaire, for the 10 events with the largest BAG score as reported by the respondent, a set of open questions was generated. For each BAG the respondent was asked to elaborate on the business agility means and how these enabled or inhibited business agility performance in response to the event. In this way, the questionnaire generated both quantitative and qualitative data on the means for business agility. Due to the length of the survey, we did a cross-check on possible survey fatigue which might bias our results. We found no difference in the variance of answers between the first half of the survey and the second half. We also checked the number of responses to individual items in the second half of the questionnaire and compared it with the first half.

For the interviews with managers within each industry a sample of organizations was selected. Criteria to select organizations were their position in the market (in the four industries top market share stakeholders with considerable size). Within each organization at least two managers were asked to fill out the survey, as a basis for the in-depth interviews. One interview was held to cover the general business or policy perspective (mainly with CEOs, marketing executives and general managers) and one to cover the operations and IT perspective (mainly with COOs, CIOs and CTOs). The average duration

[14] A copy of the full questionnaire can be obtained from the researchers.

of the interview was 90 to 120 minutes. Basis for the interviews were the perceived agility gaps identified by the respondents in the survey. From each interview minutes were taken and checked for accuracy with the interviewee.

Table 5.1 – Scores on business agility need, performance and gaps

Events	Absolute scores (on scale from 1 to 5)			Variance (max-min score over 7 Sectors)	
Capability 1: Operational	**BAN**	**BAP**	**BAG**	**BAN variance**	**BAP variance**
1) Growing demand for financial transparency and accountability (Basel-2, IAS etc)	3.40	2.93	0.47	1.80	0.72
2) New regulation at the national level	3.49	3.00	0.49	1.30	2.00
3) New security measures / IS security	3.35	2.42	0.93	1.10	1.00
4) Increased outsourcing of non-core business activities *	3.05	2.79	0.26	0.50	2.33
5) Increased outsourcing of IT related systems and personell *	3.28	2.83	0.26	0.80	1.10
6) Emerging price war (market focused on price) / shrinking margins	4.06	1.94	2.12	1.45	1.20
7) Need for lower priced services	3.32	2.43	0.89	1.50	1.33
8) Changing requirements take too long to implement into the organization and systems *	3.30	2.01	1.29	1.26	1.62
9) Major organizational change (eg merger, acquisition) *	3.34	2.34	1.00	1.31	1.00
10) Digitalisation of documents and E-signatures *	2.79	2.49	0.30	1.09	1.25
11) Increasing time and money spent on maintenance & support of the existing IT infrastructure *	3.25	2.17	1.08	0.70	1.90
12) Desire to increase the levels of expertise of employees *	2.59	2.12	0.46	0.67	1.17
13) Re-organization of internal processes *	3.49	2.65	0.84	0.48	0.04
Capability 2: Customer	**BAN**	**BAP**	**BAG**	**BAN variance**	**BAP variance**
14) Shortening of competitors' time to market of new products & services	3.00	2.20	0.80	1.40	0.50
15) Decreasing loyalty of customers	3.18	2.46	0.72	1.97	1.70
16) Need to decrease delivery time of services towards customers	3.23	2.43	0.80	2.50	2.00
17) Need for (more) online facilities towards customers	3.50	2.98	0.52	1.53	0.91
18) Need for more customized/tailored services towards customers	3.30	2.65	0.70	0.63	1.93
19) Need for multi-channel any time any place access to information & services by our customers	3.33	2.63	0.70	1.50	1.21
20) Need for quicker response to customer service requests	3.62	2.75	0.87	1.50	0.83
21) Emerging technologies to easily connect to customers' information systems	3.45	2.20	1.25	1.10	1.10
Capability 3: Business Network & Partnering	**BAN**	**BAP**	**BAG**	**BAN variance**	**BAP variance**
22) Increasing number of partnerships	3.08	2.83	0.25	1.20	1.50
23) Complexity in processes due to an increasing number of interdependencies with other services of other organizational units	3.34	2.55	0.79	1.10	0.79
24) Information sharing in the network	3.40	2.91	0.49	1.20	1.47
25) Need for structured information exchange with other organizations / integration with systems of partners in network	3.25	2.72	0.53	2.60	1.90
26) Need for easier switching between suppliers of products & services	3.58	2.73	0.85	1.30	0.70
27) Accelerating rate of innovation of product technology	2.70	2.35	0.70	1.70	0.70
internal events are marked with an asterix *	***3.28***	***2.54***	***0.75***		

We chose to study four industries in the Netherlands: logistics (logistics service providers), finance (retail banking), utilities (distribution and sales of energy) and mobile telecom (mobile telecom operators). In addition to these three industries, we also studied entities from three public sectors: central government (Dutch ministries), institutions of higher education and a category 'other public' (operational authorities like Tax authorities, local authorities etc). These industries and sectors constitute an important segment of the total Dutch industry and public sector. Organizations in all of the industries and sectors that we studied are confronted with a wide variety of external and internal events, such as regulations, shifts in customer demands, reorganizations and changes in IT.

5.4 Findings

We will present findings from three perspectives. First, we present an overview of the average scores on BAN, BAP and BAG per sector and per dimension of business agility. Second, we compare the public sectors with the business sectors on BAN, BAP and BAG. Finally, we analyze the importance of individual events per dimension of business agility.

Table 5.2 - Sector comparison on BAN, BAP and BAG for the three dimensions of Business Agility

		government	education	other public	finance	telecom	logistics	energy	Average
BAN	**average**	**3,29**	**3,25**	**3,40**	**3,29**	**3,36**	**3,63**	**3,10**	
	Operational	3,28	3,17	3,30	3,42	3,38	3,72	3,29	3,29
	Customer	3,26	3,38	3,48	3,43	3,40	3,54	2,91	3,33
	Network	3,36	3,30	3,57	2,85	3,28	3,62	3,02	3,22
BAP	***average***	***2,84***	***2,62***	***2,63***	***2,63***	***2,79***	***2,64***	***2,17***	
	Operational	2,68	2,55	2,69	2,50	2,91	2,38	2,08	2,47
	Customer	3,15	2,79	2,63	2,46	2,64	2,69	1,91	2,54
	Network	2,82	2,56	2,42	2,48	2,78	3,07	2,76	2,68
BAG	***average***	***0,45***	***0,63***	***0,77***	***0,80***	***0,58***	***1,08***	***0,96***	
	Operational	0,60	0,62	0,61	0,92	0,47	1,33	1,21	0,80
	Customer	0,11	0,59	0,85	0,96	0,76	0,92	1,00	0,79
	Network	0,54	0,74	1,15	0,37	0,50	0,81	0,38	0,60

Overall Differences between Sectors

We will present findings from three perspectives. First, we present an overview of the average scores on BAN, BAP and BAG per sector and per dimension of business agility. Second, we compare the public sectors with the business sectors on BAN, BAP and BAG. Finally, we analyze the importance of individual events per dimension of business agility. Table 5.2 compares the 7 sectors on BAN, BAP and BAG per dimension of business agility. When we look at the overall BAN scores, logistics has the highest BAN (3.63) across all 3 agility dimensions. The lowest BAN is found in the education sector (3.17) on the operational dimension, in energy (2.91) on the customer dimension and in the finance industry (2.85) on the business network dimension.

When we look at the overall BAP scores, the energy industry has the lowest BAP on the operational dimension (2.08) and the customer dimension (1.91), while the lowest BAP on the business network dimension is found in the general (other) public sector (2.42). The highest BAP is found in telecom on the operational dimension (2.91), in the central government on the customer dimension (3.15) and in the logistics industry on the business network dimension (3.07).

When we look at the overall BAG scores, the largest BAGs are found in logistics (1.08) and energy (0.96), and the largest BAGs are found on the operational (0.81) and the customer dimension (0.79). The largest BAGs on the operational dimension are found within logistics (1.33) and energy (1.21), on the customer dimension in energy (1.00) and finance (0.96) and on the business network dimension in the other public sector category (1.15).

Public Sectors versus Private Industry

When we compare the 3 public sectors with the four industries on BAN, BAP and BAG, we find a few differences. BAN is about the same within the public sector and private industry, only BAN on the business network dimension scores higher in the public sector (3.41) compared to business (3.19). BAP is higher for the public sector on both the operational and customer dimensions, but slightly lower on the business network dimension. These differences are also found when we compare the BAGs. Overall BAGs within the public sector are lower compared to private industry, with the exception of the average BAG on the business network dimension, which is considerably larger within the public sector (0.81), compared to business (0.51).

Importance of individual events and the role of IT

An analysis of the individual events will further clarify the differences between the seven sectors as related to the three dimensions of business agility. Table 5.1 presents the average scores on the twenty-seven IT related events with regards to BAN, BAP and BAG. The variance of BAN and BAP scores between the seven sectors was also analyzed. Consistent with Table 5.1, the events have been grouped into the three dimensions of business agility. The next three subsections discuss the largest BAGs per business agility dimension and the effects of IT on BAR as derived from the survey results and interviews with managers. Examples from the different sectors will be used to illustrate the findings.

Operational Agility

The event with the largest BAG (overall and within the operational dimension; BAG=2.12) is the *emerging price war and shrinking margins (# 6)*. This event influences all the business sectors analyzed and, to a lower degree, the public sectors. Companies have many difficulties coping with the required changes in their internal processes. Lowering the prices requires changes in operational processes to cut costs as it influences the way companies are structured to operate. This is an important driver for *re-organizing the internal processes (#13)* and *major organizational change (#9)*. Many respondents mentioned the case of mergers and acquisitions - as an example of major organizational change – where merging and integrating the various IT infrastructures proved time consuming and caused large gaps.

One reason behind the agility gaps on the operational agility dimension is the fact that *implementation of changing requirements within the organization and IT systems takes too long (#8)*. Many respondents indicated that many legacy systems are based on embedded business rules. In these legacy systems, data, applications and business rules are linked and part of the same software code. This makes it difficult to make changes easily and quickly, which hampers BAP. Since, *increasingly time and money is spent on maintenance and support of the existing IT infrastructure (#11)*, insufficient budget remains for investing in innovation and creating options for an IT architecture with more capability to enhance agility.

As a solution to the problems described, many organizations are considering or are already active in the *outsourcing of (IT) resources and personnel (#4 and #5)*. In our research we saw a large variance between the sectors in the perceived BAP to deal with outsourcing (#4 BAP variance=2.33). The lowest BAP was found in the general (other) public sector segment (#4 BAP=1.67), followed by the finance sector (#5 BAP=2.10). Main reasons for outsourcing are reduction of costs, standardization of the IT infrastructure and a focus on core competences. Respondents mentioned a number of difficulties involved in outsourcing. Strategic decisions need to be made regarding the degree of outsourcing. Governance of the outsourcing provider creates new transaction costs. If part of the outsourcing arrangement is based on off-shoring, governance requires dealing with cultural issues and detailed specifications of change requests. In general respondents provided both pros and cons for the proposition that outsourcing enhances BAP.

Another important change factor leading to a high BAN is *new regulation on a national level (#2)* (BAN=3.49) and specifically, *increasing demands from transparency and accountability regulation (#1)* (BAN=3.40). Financial transparency & accountability causes the highest gap in the finance sector (BAG=2.20). Examples of accountability regulation directly impacting organizations within finance are Basel 2, International Financial Reporting Standards [IFRS], International Accounting Standards [IAS] and Sarbanes Oxley. Many organizations within finance have IT systems, organized per product (group). This makes it difficult to comply with the transparency requirements enforced by the new regulations, which require horizontal transparency across various product groups.

Executives, in all the sectors that we studied, perceive a high effect- and response uncertainty with regards to government regulation measures. This leads to high BAN scores. The impact of a new regulation, the problem of incomplete regulation specifications and the uncertain timing of new regulation makes it necessary to implement the required changes in a short time-frame. This is causes BAGs within the energy (2.00), finance (1.20) and education (1.05) sectors. It is interesting to note that the telecom organizations feel that they are over prepared with a surplus of BAP (#2 BAG= -/- 1.3). Apparently, telecom organizations have found ways to deal with uncertainty in regulation.

Some events are dependent on the domain (business or public). Within the public sectors we find two events which cause relatively large BAGs. *Digitization of documents and the usage of e-signatures (#10)* create BAGs within central government (1.26) and the general (other) public sector (0.96). Digitization of documents and signatures plays an important role to streamline policy decision-making and transactions between citizens and government agencies, but has far reaching impacts on the workflow throughout and between organizations. It is this workflow impact that explains the low BAP scores. Another BAG we found in all three public sectors (with average BAG=0.97) is *increasing the levels of expertise of employees (#12)*. The information society and changing role of the public sector requires new types of expertise. The main factors hindering agility, as mentioned in the interviews, were the aging workforce, insufficient change oriented people and a loss of expertise due to the usage of temporary external expertise which does not remain anchored in the organization.

Customer Agility

The event requiring customer business agility capability with the largest BAG (1.25) is *connecting to customers' information systems (#21)*. Connecting to customer information systems requires an IT-architecture with quick-connect capabilities on the basis of open standards and the usage of middleware. Many organizations in our sample were insufficiently ready to handle these required quick-connect capabilities.

The 2nd largest BAG is found for *responding quicker to customer service requests (#20)* (BAG=0.87). Especially the sectors logistics (BAG=1.37), energy (BAG=1.30) and other public (BAG=1.04) are insufficiently ready to deal with this agility need. For many organizations these are large scale processes, with many customer service requests. Public sector organizations and respondents in the energy sector (former public) especially need a redesign of their internal processes to become more customer-oriented.

Dealing with *the shortening of competitors' time to market of new products and services (#14)* causes a BAG within the Telecom sector (BAG=1.30). There is high pressure to bring new products and services to the market within a short timeframe. For instance, the introduction of new mobile payment models, data services, new content concepts based on increased bandwidth or new location based services require fundamental changes in an organization's procedures, systems and partnerships.

Customization of services towards customers (#18) scores relatively equally on BAN over the seven sectors analyzed. Especially within the energy sector there is a low BAP (BAP=1.50). *Customization of services towards customers* is related to *decreasing loyalty* *of customers (#15)* in the Energy industry, which scores high on BAN (4.30) and also very low on BAP (BAP=1.30). Energy companies have been formed by mergers of various previously state owned energy companies, which each had their own systems and procedures. Inherited systems were never designed with a customer or service customization perspective. However, the open market requires customization to attract new customers or preserve existing customers. In the past, these companies did not have to worry about customers, since they did not have the possibility to switch to a competitor. Now this has changed, and fundamental changes are required in terms of culture, processes and IT systems.

The largest BAG within the finance industry on the customer dimension is caused by the *need for multi-channel any time any place access to information & services by customers (#19)* (BAG=1.70). The original IT architectures of large financial institutes insufficiently support adding new channels for communication and transactions. Given the increasing importance of Internet banking and the opportunities of mobile payment, there is a high urgency to change IT architectures and systems to support the Internet and mobile devices as channels for communication and transactions.

Business Network & Partnering Agility

The highest BAG in the business network dimension is the *need for easier switching between suppliers of products & services (#26)* (BAG=0.85). Especially within the logistics (BAG=1.5) and energy (BAG=1.1) sectors, the BAP is insufficient. To deal with this need changes must be made at the business network level within the industry. In the energy industry, an energy clearing house has been set up by a number of energy companies to arrange standardized information exchange and facilitate the switching of customers from one supplier to another. Defining the standards and connecting the different systems caused the most difficulties.

The *need for structured information exchange (#25)* - think about EDI and XML - causes a high variety in BAN and BAP across the seven sectors analyzed. The largest BAGs are found in logistics (BAG=2.03) and the general (other) public sector (BAG=0.94). In the logistics industry, the need for chain-wide tracking and tracing requires integration with partner information systems. Given the diversity in types of companies and size – a lot of small and medium sized companies – it is difficult to achieve chain-wide structured information exchange.

The second largest BAG is the *complexity in processes due to an increasing number of interdependencies in the business network (#23)*. This change factor scores relatively highly on BAN (3.34) and low on BAP (1.55). Specifically, respondents within the education sector (BAG=1.30), other public sector (BAG=1.34) and the energy industry

(BAG=1.10) find themselves insufficiently prepared for this business network integration. This factor is closely related to *information sharing in the network (#24)*. Increasingly, public services are interdependent and information must to be shared between different organizations in the public sector. Public services make increasing use of different registers of authentic data[15], whereby distributed databases need to be coupled to provide a complete information profile of citizens for various types of services. The Dutch government is working on a single portal for governmental services, a single point of access between citizens and the government for information exchange, information access and services. In the back office this means that a lot of distributed databases need to be connected, which creates many interdependencies.

The lowest BAP is found in managing the *acceleration of innovation in product technology (#27)* (BAP=1.35). Telecom companies are highly dependent on their mobile device and content partners to exploit this change factor as a way to innovate and distinguish themselves from competitors. This hurdle causes a BAG in the telecom industry (BAG=1.2). New technologies in mobile devices, Voice over IP, emerging data services and the merging of phone, internet and TV have resulted in a series of innovations in product technology. For telecom companies to remain competitive, customized products and services need to be put on the telecom market faster.

5.5 Analysis

Figure 5.2 shows a plot of the relative scores on perceived BAN and perceived BAP for the 27 events analyzed. First, we calculated the overall average scores on BAN (3.28) and BAP (2.54) and then related the individual scores of the 27 events to this overall average score by subtracting the overall average score from the individual score. This way, we made the relative importance and relative scores of the 27 events on BAN and BAP explicit. Based on their relative position on the Business Agility Matrix, events can lead to a BAG. If BAN scores are above average and BAP scores below average, organizations are insufficiently agile and need to take immediate action in order to deal with the specified event.

Most important events requiring immediate action as found in the research were *emerging price war and shrinking margins (# 6)*, followed by *connecting to customers' information systems (#21)* and dealing with *major organizational change (#9)*. A number of events

[15] The Netherlands has a model, whereby government organizations are legally bound to (re)use the data from a number of central registers. These so-called authentic registers are registers that are maintained by a single government body and used by many others as the authentic source of certain data. If a register is formally designated as an authentic register, all other government organizations are strictly forbidden to collect the same data by themselves. The rationale is to ensure that a Basic register is the only authentic source of the data and can therefore focus on the quality.

need to be carefully watched. If the level of uncertainty increases, they may require immediate action. If BAN is below average and BAP above average, organizations are generally over prepared to deal with an event.

It is interesting to note that respondents find their BAP to deal with events related to business network agility relatively sufficient, compared to other factors. This can be explained by the fact that on average more attention is given to internal operational business agility. As such an awareness of the importance of the business network perspective is insufficient. Additionally, solving internal problems tends to have priority over business network opportunities; especially in environments where the importance or use of a business network is unknown.

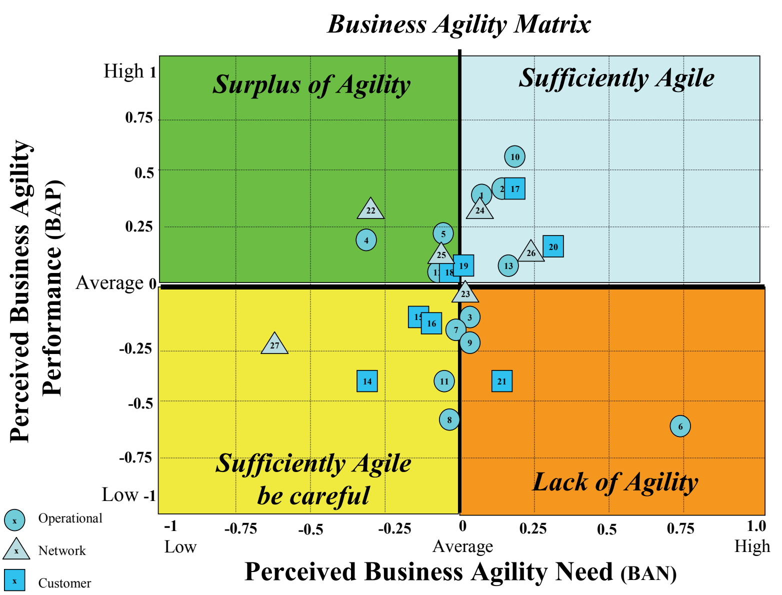

Figure 5.2 - Business Agility change factors matrix

Since Figure 5.2 only provides an overview of average scores across the total sample, the business agility matrix will look different per sector analyzed. As an example we will show the business agility matrices for the central government and finance sectors (Figure 5.3 and Figure 5.4). On sector level of analysis the relative importance of events becomes more explicit compared to the total sample, with a wider range of scores on BAN and BAP. Given the differences between different sectors on the relative scores for events on BAN and BAP, sector specific benchmarks are needed for organizations to assess and compare their BAN and BAP scores for various events.

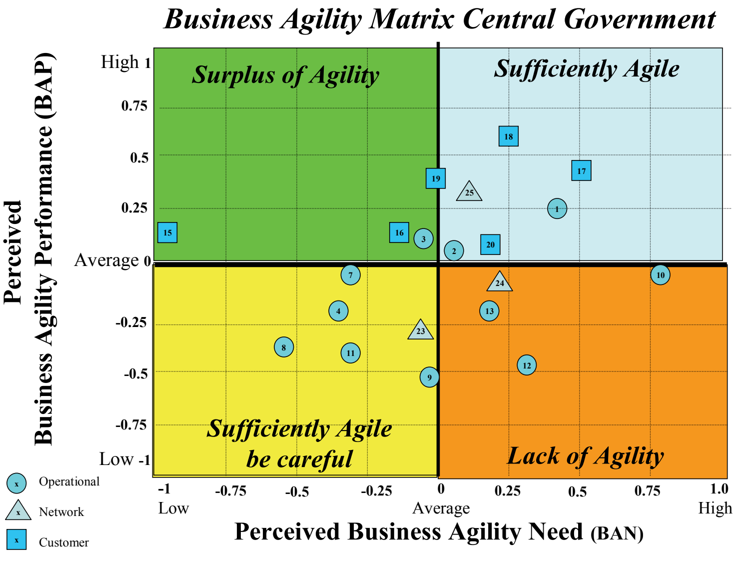

Figure 5.3 - Business Agility Matrix central government

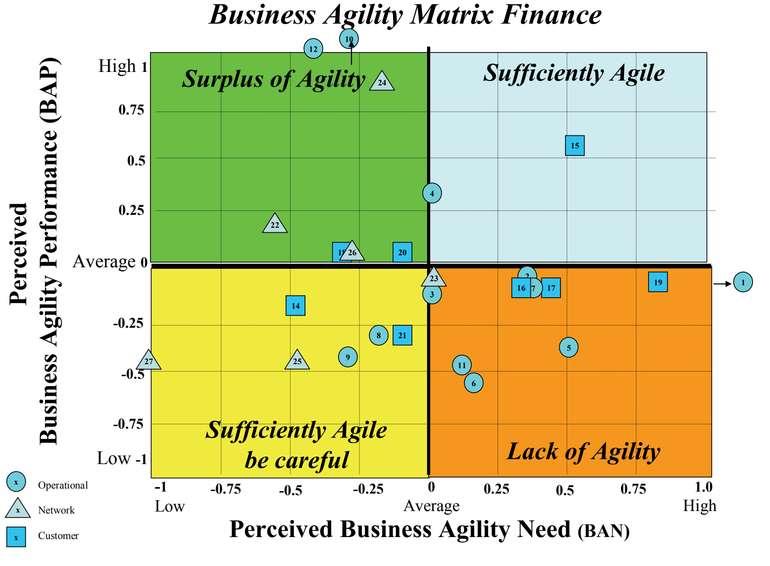

Figure 5.4 - Business Agility Matrix Finance

This study shows that some events are generic, causing gaps in all domains, but some are dependent on public or private domains. These events have a relatively similar type of BAN within all business sectors (e.g. #6) or within all public sectors (e.g. #10, #12, #24). There are also a variety of events that are sector specific (e.g. #17, #27). BAP in general is organization specific, although the same type of challenges in increasing BAP are found in all the organizations analyzed.

Depending on the position of an event in the Business Agility matrix several IT strategies can be defined (see Figure 5.5).

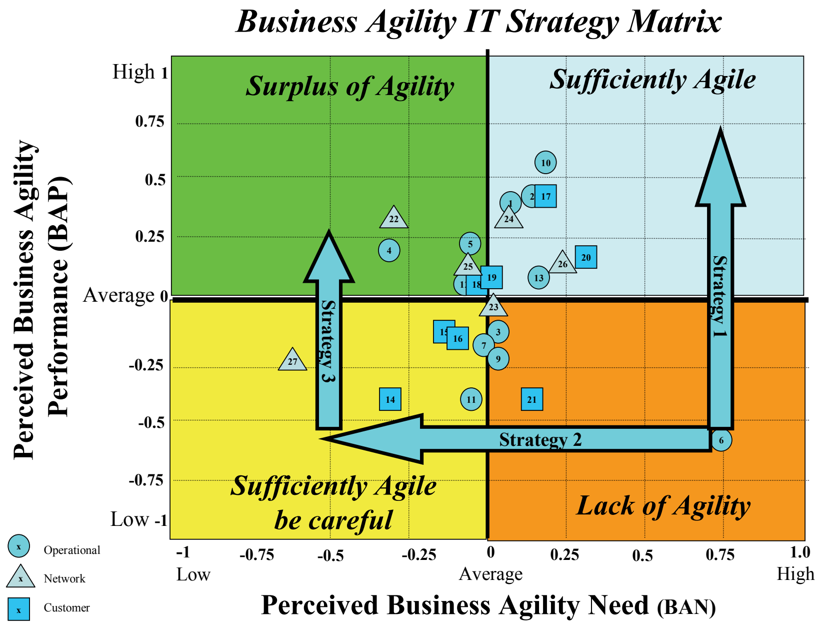

Figure 5.5 - Business agility IT strategy matrix

If an organization finds itself in the *Lack of Agility quadrant* for a certain event, two possible IT strategies can be used. In the first strategy, IT is used to increase the BAP. This includes increasing sensing, responding and learning capabilities (Dove, 2001). A few general guidelines for increasing BAP based on IT capabilities were extracted from the interviews and confirmed in the literature. Respondents believe that IT architecture and standards should be managed centrally at an enterprise level on the basis of a broadly enforced set of technology standards, while leaving room for local responsiveness. To some degree the same is true for security, risk and IT facilities management. This recommendation is corroborated by Weill *et al*. (2002). A second guideline focuses on the IT infrastructure. Specifically, an infrastructure which is modular, service-based and tailored to the enterprise's strategy (close alignment between business and IT) is expected to enhance business agility. Such an architecture is, by definition, loosely coupled, based on modular reusable components in a scalable framework (Dove, 2001). A distinction between data, applications and business rules creates the basis for more agility. Compatibility and integration can be achieved via the use of standardized interfaces and connections the use of standardized technology to store data (such as XML) and the use of interoperability and integration with supporting standards and open protocols (e.g. XML and web services) (Vervest and Dunn, 2000; Brown and Bessant, 2003). These are enablers for increasing the business network agility dimension (van Hillegersberg *et al*., 2005) as well as the internal operational business agility dimension. A final guideline, found in the literature (Weill *et al*., 2002), is that an organization's infrastructure should be created via a series of incremental investments. Staged investment means partitioning a larger IT investment into stand-alone increments that build on the preceding ones, thereby creating real strategic options (Konsynski and Tiwana, 2004).

In the second strategy, IT is used to decrease the BAN (i.e. neutralize the need for business agility). As an example, we take the *need for quicker response to customer service requests (#20)*. An IT strategy to lower BAN might be to create self service environments, where customers can help themselves or each other, based on controlled access, to data, transactions and intelligent decision support tools for solving problems. This can be extended to self-service environments, where customers are offered personalized products and services based on real-time product configurations and historic databases that match profiles to offers (like Amazon). By creating self-service environments, there will be fewer customer service requests and therefore the BAN score pertaining to the need to respond more quickly to customer service requests will decrease.

If an organization finds itself in the *Sufficiently Agile, Be Careful quadrant* for a certain event, the IT strategy should focus on increasing the sensing and learning capabilities to activate explicit knowledge on-demand from organizational memory. Sensing can be achieved by early detection systems, which will send an alert at the first signs of a new threat or opportunity. It then becomes necessary to identify the procedures allowing for a proper response (Daft *et al*., 1988; Conner, 2000). The involvement of customers in product development – so called customer sensitivity – can also be an important basis for sensing (Van Hoek *et al*., 2001; Maskell, 2001). Available, complete, pertinent, and easy-to-access information on customer needs, anxieties, and service requirements via IT is a key enabler for agility (Christopher, 1992).

5.6 Conclusions

The central research question of this chapter was '*Which events lead to a business agility need and what IT-strategies can be defined to close business agility gaps?'* This study shows that some events leading to a business agility need are generic, but some are dependent on public or private domains. The emerging price war and the need for lower priced products & services, combined with fast changing customer requests, dramatically influences all business sectors analyzed. Companies face severe difficulties in coping with the required changes. In many cases this requires a totally different way of organizing the company and its business network. Additionally, new regulation is causing high BAN in almost all sectors analyzed. Furthermore, a variety of events were found to be sector specific. Given the differences between different sectors on the relative scores for events on BAN and BAP, sector specific benchmarks are needed for organizations to assess and compare their BAN and BAP scores on various events. The results also indicate that BAN is not just created by uncertainty about external events. Many internal events (such as mergers and acquisitions, changes in systems and procedures, digitalization of documents and e-signatures) require organizations to increase their BAP. This is reflected in the BAGs that were found for various events with an internal origin in the different sectors.

BAP in general is organization specific, although the same type of challenges in increasing BAP and using IT capabilities as a means to do so are found in all organizations analyzed. Respondents are very worried about the pace at which responses to the events can be implemented. To a large degree this can be explained by the existing organizational structures, cultures and legacy IT infrastructures.

The largest BAGs were found in logistics and energy, where events requiring agility on the operational and the customer dimension caused larger gaps than the business network dimension. The largest BAGs on the operational dimension were found within logistics and energy, on the customer dimension in energy and finance and on the business network dimension in the general (other) public sector.

Depending on how an organization perceives and places an event in the Business Agility matrix, three generic IT strategies were proposed. If an organization finds itself in the *Lack of Agility quadrant* for a certain event, two possible IT strategies can be applied. In the first strategy, IT is used to increase the BAP. This includes increasing the sensing, responding and learning capabilities (Dove, 2001). In the second strategy, IT is used to decrease the BAN (i.e. neutralize the need for business agility). Finally, if an organization finds itself in the *Sufficiently Agile, be careful quadrant* for a certain event, the IT strategy should focus on increasing the sensing and learning (organizational memory IT) capabilities.

Chapter 6: Sense, Respond and Learn in four IBM cases

6.1 Introduction

Due to the rapid development of new technologies, the IT industry is one of the most turbulent industries with many uncertainties. Since the nineteen-nineties, the focus in the IT industry is moving from the hardware and software segments to the domain of services. One of the most compelling examples of this transition is IBM, whose revenues are increasingly based on providing services to its clients. The move to a service-based industry requires new types of agility to increase responsiveness and design new business models.

We now turn our attention to the IBM organization and a qualitative case study approach, within four units of IBM Benelux, to analyze different types of uncertainty and how businesses can respond with sensing, responding, and learning capabilities. From this case-study approach, we extracted insights on how Information Technology (IT) supports business agility (sensing, responding, and learning) and the factors that influence this relationship. This resulted in the development of an agility measurement instrument which can be used to explore the relationship between IT and business agility.

This chapter is structured as follows. Section 6.2 starts with a theoretical background, the research model and research questions. Section 6.3 presents the methodology used in preparing the case studies. This is followed by the four case descriptions in section 6.4. Section 6.5 presents the lessons learned and comes up with a number of propositions. The chapter ends with conclusions and limitations (section 6.6).

6.2 Theoretical background and conceptual model

The conceptual model that is used as a starting point for this study (Figure 6.1) is adapted from the literature study in Chapter 2; in particular from the work of Sharifi and Zhang (1999), Overby *et al*. (2006), Ross *et al*. (2006) and Tallon (2008). It distinguishes the uncertainty (of events), business agility needs, business agility means, business agility dimensions and business agility performance. Specifically, we discuss and analyze the role of IT capabilities as a means for enhancing business agility.

How do IT capabilities impact business agility?

Information Technology (IT) agility is defined as *the ability of Information Technology to support an organization in swiftly changing businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events*. Different researchers have analyzed the role of IT in relation to business agility. Many studies have found a positive relationship between agility of IT and business agility (Weill *et al.*, 2002; Arteta and Giachetti, 2004; Moitra and Ganesh, 2005; Hagel and Brown, 2001). The first research question analyzes the relationship between IT capabilities and business agility and the factors that influence this relationship in more detail:

Question 1: How do IT capabilities impact business agility?

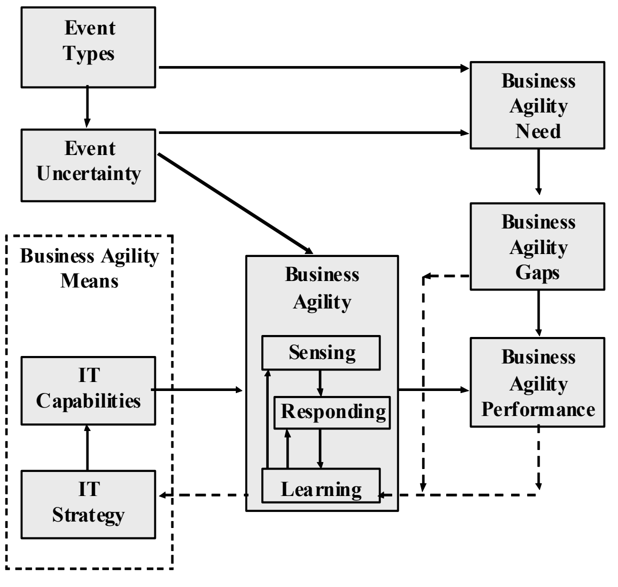

Figure 6.1 – Conceptual Model

Typology of event uncertainty

Events that require a certain level of business agility performance within firms can be characterized based on the type of uncertainty that is associated with the event. The work of Milliken (1987) is used to distinguish three types of uncertainty. *State uncertainty* relates to uncertainty whether or when (time) and where (location) a certain event will happen[16]. The event itself and the required response can be known, but there can be uncertainty about the timing and/or location of the event. *Effect uncertainty* relates to the inability to predict the nature of the event's impact (i.e. effects) on the organization. Finally, *response uncertainty* is defined as a lack of knowledge of response options and/or an inability to predict the likely consequences of an innovative response choice. Response

[16] In the remainder we will use the term *time/location uncertainty*.

uncertainty stems from cases in which organizational memory has no past response options available for reuse. If these three dimensions are combined into a typology of event uncertainty, eight possible typologies of uncertainty associated with responding to an event can be distinguished. This is illustrated in Figure 6.2.

Typology of uncertainty	Time/Location Uncertainty	Effect Uncertainty	Response Uncertainty
Very Low uncertainty	Low	Low	Low
	Low	High	Low
Moderate Uncertainty	Low	Low	High
	High	Low	Low
	Low	High	High
	High	High	Low
	High	Low	High
Extreme uncertainty	High	High	High

Figure 6.2 - Typology of uncertainty

Typology 1 uncertainty refers to events which have very low levels of uncertainty, where the organization aims to increase overall efficiency and responsiveness within a predefined response time and response range windows. Codified knowledge from organizational memory can be used in responding to such events. On the other extreme, typology 8 refers to events with very high levels of uncertainty on all three dimensions of Milliken (1987), where there is little codified knowledge available that can be re-used in the response (this is labeled '*extreme uncertainty*'). The other typologies of uncertainty are moderate in terms of the degree of uncertainty, with one or two types of uncertainty associated with the event. We expect that the amount and the type of uncertainty drive the use of sensing, responding and learning and the type of information that needs to be sensed. The second research question is defined as follows:

Question 2: Is there a relationship between the type of event uncertainty and the use of sensing, responding and learning?

Business Agility Performance

Previous research has found a positive relationship between (dimensions of) business agility and business performance (Ross *et al*., 2006; Lee *et al*., 2007). It is theorized that the effects of business agility on business performance is mediated by business agility performance. Business agility performance is defined as '*the performance of an* *organization in swiftly changing businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events.'* Businesses with high levels of sensing, responding and learning will have higher levels of business agility performance, than businesses with lower levels of sensing, responding and learning (adapted from Overby *et al.*, 2006). The direct effects of business agility dimensions on business agility performance can be assessed in terms of four change proficiency metrics (Dove, 1995; Dove, 2001): *i. response time(liness)* (the time needed to execute decision-making and change operational cycles i.e. lead time), *ii. response cost* (the costs needed to execute decision-making and change operational cycles), *iii. response quality or robustness* (on time, on budget, on specs predictability) and *iv. response scope* (the magnitude of change which can be accommodated (variety). It is interesting to analyze how different business agility dimensions impact these change proficiency metrics in terms of business agility performance. Therefore, the third research question is defined as follows:

Question 3: How do sensing, responding and learning influence business agility performance?

Eventually, business agility (performance) will have effects on the performance of the business. Examples of effects of business agility (performance) on business performance are improvements in business efficiency, an increase in customer retention rates, the generation of new revenue streams (for instance by mobilizing capabilities of business partners, which were previously considered as inaccessible (Schmelzer, 2006)) and reduction of time to market, which leads to extra revenues (first mover advantages). These direct effects on business performance are excluded from the case study analysis.

6.3 Plan of approach case study

The overall plan of approach for the case study research consisted of five steps[17]. The first step was the design of the case study. This was followed by the data collection in four case studies on the basis of desk research and interviews (step 2). The next step (3) was the design of a measurement and analysis framework, to support the analysis and codification of the empirical data. In step 4 the data was analyzed, a measurement framework was used to codify the case study interview transcripts and a cross-case comparison was made. This was an iterative process, where the measurement framework was modified and further data was collected or validated. The last step of the case study was the validation of the overall results via a workshop (step 5). The quality of a case study is, to a large extent, based on

[17] The case studies in Chapter 3 followed the same approach with the exception of Step 5. This cross case analysis is based on multiple embedded cases within one firm, while Chapter 3 analyzed different firms. In this study more and in-depth sources of data (interviews) were used compared to Chapter 3.

validity and reliability. To make a judgment about the quality level that a case study warrants, four different tests were applied during the conduct of the case study (Yin 2003): external validity, construct validity, reliability and internal validity. The following five subsections discuss the case study research steps in more detail.

Step 1 Case study design

To research the relationships between event uncertainty, IT capabilities, dimensions of business agility and business agility performance a single case study design was used with four embedded units of analysis i.e. sub cases (Yin, 2003: 40). Each case study was analyzed in its real life context and scores obtained from the embedded cases were analyzed in a qualitative manner (Dul and Hak, 2007: 45). The organization (local business unit) within the IBM Benelux organization was the core level of analysis. We tried to find cases on the extremes of the spectrum of possible case studies relating to events with different types of uncertainty (e.g. with relatively low levels of uncertainty and relatively high levels of uncertainty). We also looked for cases with low levels of time/location uncertainty and cases with high levels of time/location uncertainty. Finally, we looked for cases with high levels of effect uncertainty and low levels of effect uncertainty. Eventually, four cases were selected, based on their fit in the framework on event uncertainty and the willingness by the managers to collaborate in the research and share information. Each case study highlights a need for business agility, how IBM responded, and the effects of IT capabilities on business agility and business agility performance. The four case studies are plotted in Figure 6.3.

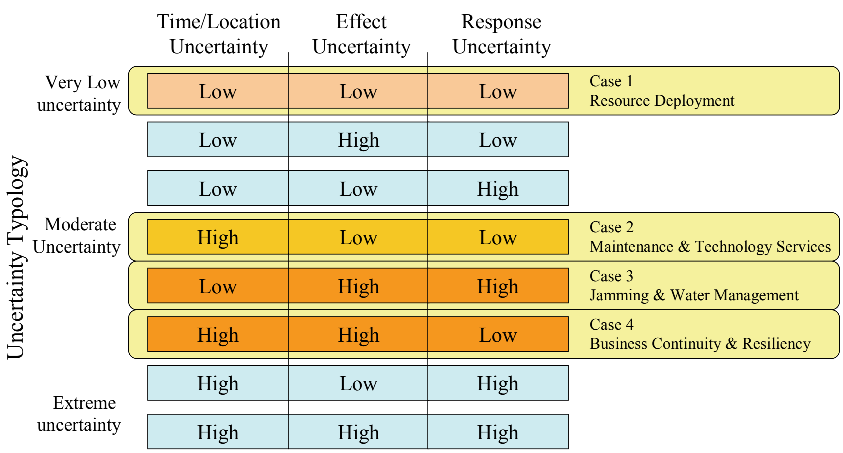

Figure 6.3 - Multiple case studies IBM Benelux

External validity (also called generalizability) is the extent to which the outcome of a study, the cause-and-effect relationships, in one instance or in a group of instances can be applied to instances other than those in the study (Dul and Hak, 2007). Since all cases are within the same company context (IBM), variety on some dimensions will be limited. However, the cases differ in type of uncertainty of the event and the type of business agility dimensions. Some generalizability of the model is expected on the relationship between types of uncertainty and the effect of IT capabilities on business agility and business agility performance for firms that offer services to customers.

Step 2: Data collection

Several tactics were used to maintain *construct validity* in the data collection phase (Yin, 2003). First, multiple sources of evidence were used to conduct the research. Yin (2003) identified at least six sources of evidence in case studies: documents, archival records, interviews, direct observation, participant-observation and physical artifacts. Data triangulation was applied by using different data sources (documents, interviews, internal reports) from different perspectives (business perspective versus IT perspective and managerial perspective and employee perspective). For this study a database was developed with different sources of evidence. This includes documents and the transcripts of the semi-structured interviews. The case study database is enclosed in Appendix D (interview list) and Appendix E (list of documents used). Another tactic that was used to maintain construct validity in the data collection phase was the review of the draft case study report by key informants within the case study organization. In order to minimize errors and biases in the study the *reliability of the data collection process* is an important quality criterion for case study research (Yin, 2003). The objective in maintaining reliability is to make sure that the same procedures are followed during the conduct of the different interviews. A case study protocol was developed to ensure a high level of reliability. The case study protocol is enclosed in Appendix F.

Step 3 Measurement framework design

In line with the suggestion of Overby *et al*. (2006) we decided to analyze and measure business agility as a function of the firm's individual sensing and responding capabilities. Learning capabilities are added as a third group of capabilities. Measurement scales from existing survey instruments were used as a starting point to construct a measurement framework, which, in turn, was used to codify the maturity of specific business and IT capabilities in the four case studies. To analyze sensing and responding capabilities at a more detailed level, the market orientation scale of (Kohli *et al*., 1993) and (Grewal and Tansuhaj, 2001) was used. As a starting point for developing measurement scales for learning capabilities, the work of (Tippins and Sohi, 2003) was used. The sensing construct was decomposed into four variables: internal data acquisition (intelligence generation, ref.

Kohli *et al*., 1993), customer data acquisition, partnering data acquisition and sense-making. The responding construct was decomposed into nine variables: internal response design, customer response design, partnering response design, internal decision-making, internal response implementation, customer response implementation, partnering response implementation, quick-connect with partners and response performance monitoring (Kohli *et al*. (1993) use the overall construct responsiveness). The learning construct was decomposed into seven variables: internal declarative memory, internal procedural memory, internal information dissemination and external information dissemination, internal learning feedback, customer learning feedback and partnering learning feedback.

The examples and quotes from the interview transcripts were used to codify the four case studies. Nominal scales [Yes/No] were used to codify the existence of specific items. In the event that specific items were not mentioned during the interviews, we assumed that these items do not exist or are not present. Scores of variables were compiled, based on the average codification score of the individual items. Scores were recoded as 'Low' (score < 2.5), 'Medium' (score >=2.5 and score <= 3.5) or 'High' (score > 3.5). The measurement framework is enclosed in Appendix B and C. Construct validity is concerned with the development of correct operational measures for the concept being studied and the objective collection of data. The (sub-) constructs and variables that were used are based on existing measures and survey measurement instruments from the literature. These existing sub-constructs and variables were supplemented with a number of new variables to adapt the existing measures to the context of agility. No pre-tests or statistical analysis were made to measure the reliability of the constructs. For the purpose of this study - to illustrate possible relationships among variables – internal validity is sufficient.

An indirect approach was used to analyze business agility performance. In each case study an assessment was made on the business agility performance to a specific event, using the four change proficiency metrics of Dove (1995, 2001). Each change proficiency metric was assessed by the researcher on a scale from 1 to 5 and recoded as 'Low' (score 1 or 2), 'Medium' (score 3) or 'High' (score 4 or 5).

Step 4: Data analysis

The four embedded case studies were used to validate the conceptual framework, answer the research questions and come up with a number of testable propositions. We expect that certain conditions (in this study, higher levels of IT agility) will lead to other conditions (higher levels of sensing, responding and learning and higher levels of business agility performance). Based on the interview transcripts, the case study events and data were coded into numerical form (scores ranging between 1 and 5) for the business capabilities, IT capabilities and business agility performance constructs. To assess the validity of the outcome of the initial data analysis, a sensitivity analysis was conducted in which changes were made at random in the codification of items (Yes or No) for 10% of the items. If the expected relationships (patterns) still hold, then the internal validity is stronger

Based on the different variables in the conceptual framework a case evaluation framework was defined. This framework was used in the analysis of each case study. The case evaluation framework is presented in Table 6.1. Items marked with (*) refer to the maturity levels based on codification by the researcher (as discussed in Step 3).

Table 6.1 – Case evaluation framework

Variable	Sub dimension	Explanation
Event	Event Type	Description of event
	Event uncertainty	Typology of event uncertainty, based on Milliken (1987): time/location, effect and/or response uncertainty
Business agility Need		Type of business agility need, based on the classification of Ross (2008)
Business Agility	Sensing	What is sensed? How is the event sensed? What is a critical success factor? What are enablers and inhibitors? What is the maturity?(*)
	Responding	How is responded to the event? What is a critical success factor? What are enablers and inhibitors? What is the maturity? (*)
	Learning	How is learned from the event? What is a critical success factor? What are enablers and inhibitors? What is the maturity? (*)
IT capabilities	Sensing IT	How do local and global IT capabilities enable or inhibit sensing? What is the maturity? (*)
	Responding IT	How do local and global IT capabilities enable or inhibit responding? What is the maturity? (*)
	Learning IT	How do local and global IT capabilities enable or inhibit learning? What is the maturity? (*)
IT strategy	Enterprise architecture	What is the enterprise architecture maturity? How does it impact business agility?
	Knowledge management	How does the IT strategy support knowledge management? The focus can be either on codification (knowledge is captured, codified and stored in databases) or on personalization (IT is used to support knowledge sharing through person-to-person contacts).
	IT-business alignment (BITA)	To what degree is there alignment between business and IT? What inhibits BITA?
Business Agility Performance	Timeliness	Assessment of timeliness of the response
	East (cost)	Assessment of ease of the response
	Range (variety)	Assessment of range of the response
	Quality	Assessment of quality of the response

Step 5: Validation of results

As a final step in the case study a workshop was organized with representatives from the different IBM units to discuss and validate the results of the cross case analysis.

6.4 IBM case studies

6.4.1 Introduction

For years IBM has been a provider of hardware and software. In 1993 it became clear, that the portfolio IBM had at that moment (focused on hardware, especially mainframes and software) no longer matched the demands in the market. Customer demands had changed to client-server computing. IBM was confronted with huge negative financial results. The value of IBM shares dropped significantly and the company was on the verge of collapse. IBM's business model of selling mainframes was out-of-date. This came as an unexpected surprise. IBM was in denial. When losses increased, a crisis situation resulted. IBM was forced to change and adapt. In 1993, Louis Gerstner became CEO of IBM. Under the guidance of Gerstner, IBM cut billions in expenses (partly through massive layoffs) and raised cash by selling assets. Gerstner led the changes for a new corporate culture at IBM (Gerstner, 2002). This new corporate culture laid the foundation for IBM to become an agile company.

Since this financial crisis in 1993, IBM has been in a process of continuous transformation and change from a hardware/software company to an agile services company. Even today this process is still continuing. During the years since 1993, IBM has gradually moved out of the hardware domain. First, IBM sold their network equipment business, such as routers. More recently the storage business was sold to Hitachi and the PC and laptop business to Lenovo. Research performed by MIT Sloan CISR (Weill *et al*., 2006) shows how the business model of IBM has changed dramatically. In 1991 the majority of the revenues (57%) came from manufacturing (creator business model). In 2005, 52% of revenues came from services. The hardware segment was reduced from 24% in 2000 to 9% in 2008 (source: IBM Annual report 2008). The move to a different business model requires different competences to remain successful (Weill *et al*., 2006).

In 2002, IBM announced the beginning of a US$10 billion program to research and implement the technology infrastructure necessary to be able to provide supercomputer-level resources "on demand" to all businesses as a metered utility. An on-demand organization has its business processes integrated end-to-end across the company and with key partners, suppliers and customers, so that it can respond with speed to any customer demand, opportunity or threat. Since 2002, IBM has implemented the on-demand concept in its own organization and supply chains. The focus has changed from the internal organization to partners (i.e. partnering agility) and customers (i.e. customer agility). The on-demand environment requires that static supply chains with business units and geographic silos become integrated processes from end-to-end across the enterprise. Value is driven from process innovation and improved productivity. In three years' time this strategy led to an estimated cost reduction of nearly 20 billion US dollar (Luby, 2005).

The enormous costs of the internal IT infrastructure were among the reasons for the financial crisis at IBM in 1993. Therefore, IBM decided to reorganize its IT infrastructure. IBM started a process of worldwide standardization, integration and consolidation. As an example, IBM had 126 computing centers in Europe. These were scaled back to 2. Previously, each country had its own IT organization and IT systems, such as salary systems, financial systems, invoicing systems. This structure was consolidated into one central and global IT organization. The IT organization of IBM is now organized worldwide from delivery centers. IT services are standardized to a large degree and offered at the lowest possible costs. IBM uses global sourcing (i.e. off shoring). This reorganization led to dramatic cost reductions for the IT infrastructure. In turn, management decided to change their strategy and use part of the IT budget, which became available due to the lowering of IT costs, for business innovation and application innovation. One the one hand the traditional IT infrastructure was restructured; on the other hand a new environment was built up.

The IBM IT landscape is a heterogeneous mix of legacy information sources and applications, new functions incorporating the latest technologies, and third-party products with varying degrees of customization. IBM is centralizing and integrating its applications and databases via architecture definitions and strategies, both at the enterprise and business unit levels. IBM uses a number of centralized corporate information systems, which are connected to each other via IBM web sphere software (message-bus principle). These systems are reconfigurable, based on the capability to set and change parameters. For these central systems, IBM uses standard software packages as much as possible, including Siebel for monitoring its prospects and customer account information and *SAP* for storing and managing its contracting process, for its financial administration (including invoicing) and for reporting purposes. All information from the different systems is placed in one relational database (data warehouse). Via portals, IBM managers can make a multitude of queries on this (historic) data. The centralization of systems and data provides IBM continuous insight into current and future performance and revenues. This strategy helps IBM hedge against a new financial crisis, like the one experienced in 1993. With the focus shift of IBM to an on-demand business, IBM increasingly collaborates within an eco-system of business partners.

IBM is organized globally along three segments: Services (Global Technology Services GTS and Global Business Services GBS), Software (SWG) and Systems and Technologies

(STG) and Global Financing (IBM Annual Report, 2007). The organization chart of IBM MNT Benelux and the focus of the case studies (highlighted) are shown in Figure 6.4.

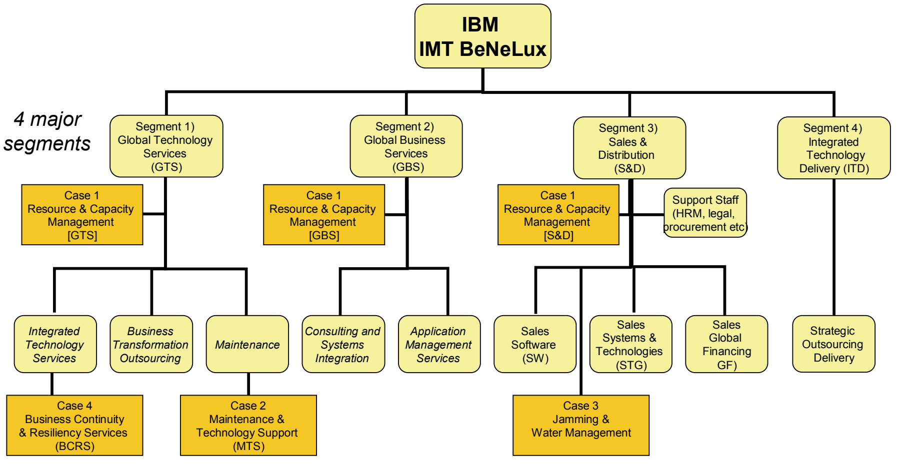

Figure 6.4 - Overview IBM Benelux (and case studies highlighted)

The IBM resource and capacity management units are responsible for capacity planning, fulfillment of the resource requests within the requested timeframe to deliver customer commitments and development of IBM professionals and leaders in line with the strategic and individual development plans. IBM Maintenance & Technology Support (MTS) is responsible for the support of hardware and software at IBM and third parties. IBM Business Continuity & Resiliency Services (BCRS) provides disaster recovery-, data security- and managed resiliency services. The IBM Centre of Excellence for Water Management is an example of the new business model of IBM, where a customer- and problem-driven competence centered approach is used in collaboration with external partners to develop market expertise while serving as a gateway for IBM-products and services.

6.4.2 Case 1: IBM resource deployment and workforce agility

Introduction

An agile workforce is key to business agility (Kidd, 1994; Goldman *et al*., 1995). This applies especially to service oriented organizations, where knowledge workers are one of the core assets. Workforce agility includes sensing the need for specific types of resources (skills), responding to specific customer opportunities and learning, by adapting resource deployment strategies. Organizations need to have the ability to adapt to fluctuations in customer demand and changes in their environment in order to be successful and survive.

Customer demand for the type of services offered can change, which may require different skill sets, as well as the quantity of the workforce. Managing resources is one of the key internal capabilities for IBM, since human resources are responsible for about 80% of the operational costs. The IBM resource management units have three main objectives and key activities *Workforce management* (capacity planning) ensures IBM has the right skills and workforce mix (junior-senior, job categories) within the organization and among the partners. *Resource deployment* is about fulfillment of the resource requests within the requested timeframe to meet customer commitments. Resource deployment matches demand and supply for people (like an internal employment agency). *Resource development* is about developing IBM professionals and leaders in line with strategic and individual development plans. Professional development includes the development process to upscale IBM employees' skills but also the selection of new hires.

Business agility need

Resource deployment is a standardized and structured process, which depends to a large degree on IT. Demand for resources in most cases is known in advance to a certain degree, but sometimes demand is ad-hoc. For known demand, long-term opportunities are translated into the IT tool Demand Capture. Once opportunities become concrete and short term, demand is specified via *open seats* (OS) in the IT tool Professional Market Place (PMP). Open seats are specific job roles related to projects that are being tracked in Siebel and PMP and include only those roles for which a specific resource has not yet been identified. An example of ad hoc demand is the sudden departure of a candidate on a project. In such a case, an immediate replacement is required.

Sensing, responding and learning

Figure 6.5 shows the resource deployment process for *known demand* in IBM GBS and IBM GTS. We distinguish sensing, responding and learning activities and the supporting Information Systems and Tools used by IBM GBS and IBM GTS Resource Deployment. Based on the empirical research eleven activities were identified. Three activities (5, 7 and 9) are (partly) sourced from external partners. The PMP system and related tools provide the core IT, which supports the resource deployment business process. All IT which is used is developed and offered at the corporate level. The sensing-, responding- and learning capabilities as part of the resource deployment process are described in more detail.

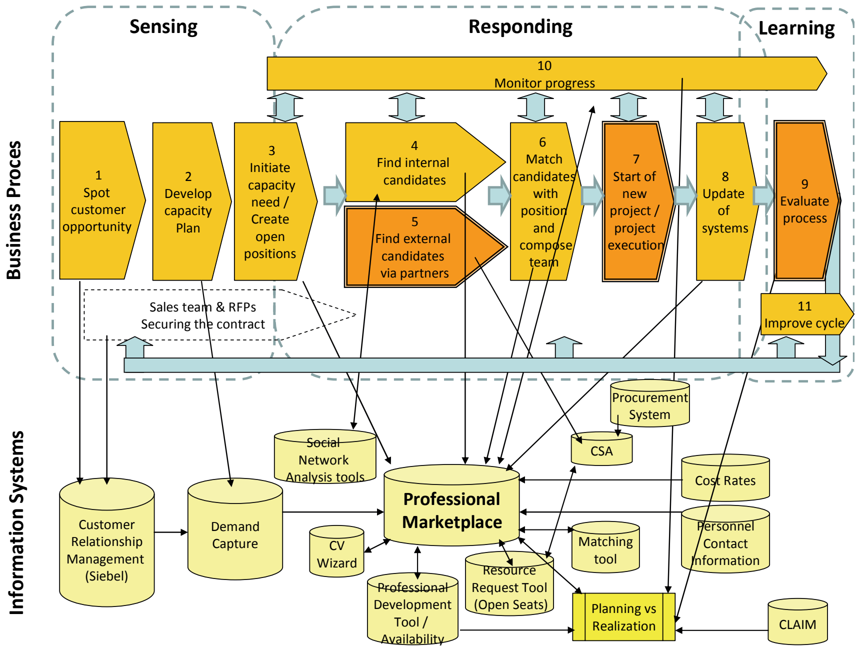

Figure 6.5 - Resource deployment process and core Information Systems and Tools IBM GBS/GTS

The process starts with registering a customer opportunity in the Siebel system by the business owner (activity 1). This system provides a pipeline on the status of acquisitions and future revenues for IBM. In phase 4 or 5 of the opportunity, a capacity plan needs to be made for the opportunity, which includes the type of expertise required. If the opportunity becomes more concrete, the exact demand is specified by the business in the DEMAND CAPTURE tool, which is a predecessor of the Professional Marketplace (activity 2). This relates to longer term opportunities, which expect to start after three months or a year. The resource manager can help the opportunity owner to specify the demand and required skills, since there are many options to choose from. Once the opportunity is expected to start as a project within 3 months, it is registered in the Professional Marketplace (activity 3). These two systems are linked, so opportunities can move (automatically) from DEMAND CAPTURE to the Professional Marketplace, depending on the timing of the projected project start. Over time, the opportunity and demand for resources can change due to progressive insight by the opportunity owner on the exact demands of the customer.

The resource deployment group starts to look for (possible) candidates, once the demand has been specified in the Professional Marketplace (activity 4). Resource deployment seeks to respond with potential candidates in two working days. Priorities and speed of response depends on signings (signed contracts have priority), core customers versus non-core customers, and external projects have right of way over internal projects. In the PMP the job-role-skill set of the employees are clear, as well as the availability in time.

First, the matching module for intelligent matching of profiles (CVs) with open seats is used. This generates a list of candidates which completely (100%) fulfill the requirements. In the event that there are no candidates completely fulfilling the requirements, the resource manager will look for alternatives. In all cases, the resource manager supplements the knowledge from the Professional Marketplace with their own personal knowledge of potential candidates to match persons to positions (activity 6). Other aspects which are taken into account are the current projects and positions of candidates, opportunities for the use of a more junior candidate, personal situation and ambitions of candidates, travel times *et cetera*. Recently, users have started to use the collective intelligence of the network. Via social network analysis tools, the position of people in the (communication) network is made transparent. This helps to achieve quicker skill-matches.

"…This information on the (communication) network can be used to find out the (real) position of a person in the network, for instance whether this person is a key player on a specific topic. This information then can be used to achieve quicker skill-matches, using the information of the network. Whether this concept will be implemented on a wider basis is still questionable, since some people perceive it as big brother, which is watching you." ***Quote #1-4, Resource Management Leader, Global Technology Services***

In seeking candidates the resource manager first looks for candidates from IBM GBS and the specific line of business, then from other groups in IBM IMT Benelux. If s/he cannot find a candidate in the Benelux region s/he looks for candidates from other regions or other lines of business. Finally, some activities might be done in offshore global delivery centers or by people from offshore locations, who temporary work onshore. IBM also works with external partners (subcontractors) to fill positions.

In the delivery of projects - depending on the area - up to 60% or even 80% of the staffing of IBM GTS is done with external people from partners. Also IBM GBS works with external partners. If it takes too long to fill in a position with IBM employees, when specific niche knowledge is required or when there is a strategic decision to use flex workers for a specific project, assignments in the IBM professional marketplace can also be made accessible to the market of suppliers (activity 5).

A number of feedback and control loops are engineered into the process of resource deployment. PMP includes feedback and alerts on the status of open seats. Another important monitoring activity and feedback loop is the weekly meeting with business group leaders (activity 9 & 10). The key performance indicators are discussed there: signings, revenues and utilization rates (occupation degree of consultants on external and internal projects). Also project specific issues can be discussed if needed. The outlook is also discussed, which compares execution (realization on projects) to the original planning. Execution is based on the data, which is available in the IBM CLAIM tool. The resource deployment process is highly dependent on the discipline of users of PMP and the professionalism of the resource managers.

"A critical success factor for the capacity resource deployment process to work well is that demand is made visible in PMP. Since the whole world can look into PMP this improves the chance of finding the ideal candidate for a position. The second critical success factor is the professionalism of the resource manager, the skills and expertise to make priorities and apply the 10 golden rules of resource management well." ***Quote #1-5, resource management leader IBM GBS***

The team of GBS resource managers uses a team room to share knowledge. One of the documents which is shared and kept up to date is a list of core accounts (spreadsheet). Also all kinds of process instructions are stored in the team room. One of the key process instructions is the *ten golden rules of resource management*, which has been defined by IBM worldwide. This checklist helps resource managers in their work and setting priorities.

IT capabilities support for sensing, responding and learning

In 2004, working closely with human resources (HR) executives, IBM Global Business Services and the company's Integrated Supply Chain division (ISC) developed a labor management system called the Workforce Management Initiative (WMI). This system tracks its employee resources in a manner akin to the ways in which an enterprise resource planning (ERP) system tracks product availability. One aspect of WMI is Professional Marketplace (PMP), which provides partners, project managers and resource deployment managers with access to real-time information about available professionals and open positions. This information allows them to make more efficient and strategic staffing decisions for projects worldwide. This tool replaced a series of standalone and one-off databases and provides near real-time updates to the data. The previous systems used to be updated only once a week. The data was rapidly out of data and therefore these systems were rarely used. Resource deployment managers relied on informal networks and personal tracking sheets to keep up to date (Robbins 2007). The concept of PMP is illustrated in Figure 6.6.

Figure 6.6 - Overview of Professional Marketplace IBM (source IBM 2007 (D-15))

The Professional Marketplace tool (PMP) and a number of other tools, which are linked to PMP are the most important IT capabilities supporting sensing, responding and learning in resource deployment. PMP provides real-time visibility to search across professional profile information such as resumes, skills, cost, engagement and availability information. This way partners and resource deployment managers have the information they need to assign resources more quickly, streamline the deployment process and create increased value for clients. PMP is an IBM worldwide work deployment tool, which works like a Google search on a number of IBM databases. This tool is used by all IBM employees. Employees can use it to look for interesting new assignments and update their CV and Professional Development. Managers use it for managerial purposes and for advertising needs by entering *open seats* (resource requests). There is a matching module for intelligent matching of profiles (CVs) with open seats. This tool is used by the resource deployment staff. The tool is used to support finding employees with the right skills, availability and (possible) interest in a specific assignment. The Professional Marketplace is also fed with profile data originating from other IT systems, such as information on the manager, detailed contact information and cost rates.

In the past, collaboration between external partners (tier-1 or non tier-1 partners) and the procurement department was done via open seat data transferred in a manual manner. This generated a lot of phone and e-mail traffic between the resource manager, procurement and external partners. In summer 2008, the Contractor Sourcing Application (CSA) tool was introduced, where (partly anonymous) open seat data from IBM Marketplace could be repeated. CSA is a strategic web-based application used by IBM and pre-defined core suppliers for the procurement of external resources to perform services. This tool is also coupled with the procurement system, which includes arrangements with preferred (tier-1) suppliers and tax-related tariffs.

An important requirement to support resource management is quality and transparency of data in the various tools. The planning information (from the PD tool) is monitored and kept up to date on a daily basis by the GBS resource managers. Consultants are asked to verify and update their planning information on a bi-weekly basis. The consultants themselves are responsible for keeping their skill set and CV up to date. This requires a lot of discipline. Resource managers monitor how often CVs are updated and if necessary remind employees to update their CV. One of the key challenges currently hindering the agility of workforce deployment within IBM GTS is the quality of the data in the different databases of the Professional Marketplace.

"The data which comes from PMP does not provide 100% visibility on the availability of employees. It can be the case that PMP indicates that someone is available, however in practice this person has been set to work on an internal project or activity, which could not be registered via PMP. The available IT provides input and a filtering function, however the eventual matching remains human work. For instance soft skills are difficult to store in tools such as CV-Wizard and PD-tool. Sometimes resource deployment managers need to talk to people personally and let them talk with a customer to come to a good match." ***Quote #1-2, Resource management leader IBM Benelux S&D***

".... In practice people don't have the time or do not take the time to keep these systems up to date. This makes adoption of these systems in practice very difficult." ***Quote #1-7, Consulting partner, IBM GTS Benelux***

"The biggest challenge is quality of the data. If ten people put their CV in CV-Wizard, you will get ten different CVs. The level of detail and activities which are described to be of interest differ a lot. Also keeping data in the CV up to date is a problem. Employees need to keep different databases up to date (CV-Tool, PD tool), this is quite time consuming. It requires self discipline to keep it up to date. Often we need to chase people to keep these databases up to date. Sometimes it is garbage-in is garbage-out. People are not available, while the system said they were. Their job position has changed etcetera. The managers and employees themselves are responsible for high quality data. Employees are made responsible for their own data. However, employees do not (sufficiently) look in these systems. The more people distrust the quality of the data in these systems, the more they use informal networks as a turnaround to solve resource deployment issues. If they directly negotiate with people, they feel that they keep control of the situation. Especially in parts of the organization where there is a lot of time pressure, such turnarounds are used." ***Quote #1-8, Resource Management Leader, Global Technology Services***

A challenge and struggle is to motivate end users to keep these systems up to date. This interferes with the agility of IBM to react to customer prospects. The sooner an IBM manager can find people with a certain expertise and the sooner he knows that someone is available, the more efficient he can begin work on responding to a customer demand or change in the market.. GTS resource deployment uses different strategies to increase usage of the Professional marketplace tools and improve the data quality.

"We try to implement these systems as the trusted source to be used. Every two weeks all managers receive a report on the (data)quality of their team. This report consists of insight into how many people updated their profile, did all the assignments and kept their availability up to date. We hope this helps to improve data quality. We also ask the managers to not accept informal networks as turnarounds. Some managers understand the game, others still are inclined to fall back to informal turnarounds. This also requires a change of culture. We are improving compared to previous year and the years before that. Quality levels are up to 80 and 90%. Trust in these systems is increasing. And quality precedes trust." ***Quote #1-9, Resource Management Leader, Global Technology Services***

Adoption and usage of Professional Marketplace tools is hindered by insufficient trust of managers (and users) in the Professional Marketplace and insufficient support for the implementation of PMP tools.

"Managers have become tired of using these systems due to past experience. They do not always have trust in these systems. In 2000 a first version of these systems was introduced. The mechanisms were not as smooth and well working as they are now and the applications in those days were with black-and white screens and did not look as fancy as they do now. Another point of interest is the way these tools and systems are introduced into the organization. ..... Tools which are developed centrally look nice and fancy. These tools are provided to the resource management organization or project management organization and handed over to the end user......There is some central instruction on how to use the tools but that is not sufficient to have end users adopt and use the systems well." ***Quote #1-10, Resource Management Leader, Global Technology Services***

It appears that there is alignment at the strategic level between business and IT to use tools such as PMP as part of the resource management processes, but there is a lack of alignment at the operational level.

"There is alignment on strategic level between business and IT how to deploy resources to projects. However there is a lack of alignment on infrastructure/operational level. IT systems are available and in place, however there is a problem on the business operational infrastructure side: people do not use the available systems as intended. The IT systems have no value, if they are not used (properly)." ***Quote #1-11, Consulting partner, IBM GTS Benelux***

Business agility performance

IBM expects a number of benefits from the use of the Professional Marketplace for resource management (source: D-16). PMP can help to improve rebalancing of expertise. PMP is also used to channel education and learning budgets to areas supporting growth.

PMP accelerates the staffing of growth areas, staffing of customer projects and the development of new permanent growth areas. The PMP enables IBM to quickly adapt the workforce to business up's and down's and the move from fixed to variable labor cost structures (extending partnering agility). Fulfillment rates have improved with engagements staffed 20% faster and with better matches to the exact qualifications requested by the client. In addition, there is nearly a 10% decrease in the use of subcontractors due to better utilization of internal employees. Improved efficiencies have saved IBM US$500 million thus far, with expectations of far greater savings when the system is fully up and running[18]. Since the use of PMP, IBM claims the utilization rate - the amount of time that consultants spend on billable tasks - has risen significantly. Also, the program has increased client satisfaction. Consultants dispatched to lead projects are more likely to have the targeted qualifications requested by the client than they were in the past. Consultants also arrive at their assignment locations more quickly.

Analysis

This case is about the agility of resource deployment to respond to customer opportunities and the use of IT to support that process. Based on the empirical evidence we analyzed the business agility performance of IBM resource deployment, to respond to a customer opportunity and match the need for resources with available resources, from the perspective of four change proficiency metrics (Dove 1995, 2001). Although the introduction of the PMP (and its predecessors) has been a long process, its use has potential and already has helped to increase IBM’s business agility performance. The system helps to sense projects in the pipeline and directly feeds (medium and longer term) resource management processes by identifying required adjustments in the human resource mix (skills and quantities). The PMP increases respond capabilities by decreasing the time to find skill matches, increasing response capability by (dis)connecting to the capacity of partners and overall reducing time to compose a project team to fulfill customer requirements. IBM is opening up the Professional Marketplace for its partners to increase their respond capability. This helps IBM accelerate the matching of demand to supply and increase agility in deployment of internal or partners’ employees on assignments. Continuous feedback by PMP on data quality and matching scores supports the learning process. Response time scores high (relatively short response times). The use of PMP has helped to shorten the time to find potential candidates to fill in open positions for a customer opportunity. Response ease (costs) scores medium. Although PMP has made the matching process easier, it still takes time and human interventions to achieve good skill matches. Response quality scores medium. Especially the (lack of) data quality in the different systems is a challenge that hampers the quality of a response. The use of

[18] http://www-935.ibm.com/services/us/index.wss/casestudy/gbs/a1026109?cntxt=a1000044

innovative IT exploiting the intelligence of the network can help to increase response quality and achieve better skill matches. Response range scores medium. Since PMP and related tools are not used within all segments and departments of IBM and not all requirements can be made explicit within PMP, response range still has room for improvement. In these situations bridging social capital (i.e. human relationships) and human interventions are of vital importance. Table 6.2 provides an analysis of the case study based on the case evaluation framework.

Table 6.2 – Analysis case 1 Resource deployment

Variable	Sub-dimension	Case 1
Event	Event Type	A customer opportunity, which requires resource deployment
	Event uncertainty	Requests for resources are relatively certain
Business agility Need		Need for business efficiency agility
Business agility Sensing	What is sensed?	Data on customer opportunities, workforce requirements, staff capabilities and staff availability
	How is it sensed?	Via leads in pipeline (before they are entered in PMP) and data in PMP
	Critical success factors	Codification of customer opportunity (in terms of related workforce requirements) and staff capabilities and (maintaining) quality of data in PMP
	Enablers and inhibitors	Enablers: various tools Inhibitors: lack of data quality
	Maturity	Medium, acquisition of data via partners relatively low
Business agility Responding	How is responded to the event?	Find possible candidates, extend range to external partners if required, match open seats with candidates
	Critical success factors	Matching algorithm from PMP combined with personal knowledge of resource deployment staff on professionals' capability to quickly connect with external partners to increase numerical flexibility
	Enablers and inhibitors	Enablers: matching algorithm from PMP Hindrances: lack of data quality, incompatible working procedures among different units, improper use of tools
	Maturity	Medium, relatively low levels of partnering and customer agility, medium levels of operational agility
Business agility Learning	How is learned from the event?	Process is continuously monitored and measures are taken to improve data quality. Tools are used to learn about the social network and the position of people to improve future matchmaking process
	Critical success factor	Learning from the data (quality)

Variable	Sub-dimension	Case 1
	Enablers and inhibitors	Enablers: monitoring of KPIs, weekly business group leader meeting
	Maturity	Medium to High, low levels of external information dissemination
Sensing IT capabilities	IT capabilities	Global IT supports sensing (CRM/Siebel and Demand Capture)
	Maturity	Medium
Responding IT capabilities	IT capabilities	Global IT supports responding (Professional marketplace + tools) and connecting to external partners (Procurement System and CSA tool)
	Maturity	Medium to High (quick connect IT and response performance monitoring)
Learning IT capabilities	IT capabilities	Global IT tools (Professional Marketplace and CLAIM) are used to compare and evaluate planning versus realization. Social Network analysis tools are used to learn about the position of people in the network to improve the matching process.
	Maturity	Medium, relatively low maturity for learning & feedback IT
IT strategy	Enterprise architecture	Standardized Technology phase
	Knowledge management	Focused on Codification of opportunities, skills and people availability in organizational memory IT
	IT-business alignment	There is a lack of operational IT-business alignment (problems with data quality, distrust in IS with (informal) turnarounds as a result)
Business Agility Performance	Timeliness	High (reducing time for matching)
	East (cost)	Medium
	Range (variety)	Medium (PMP not used within all IBM departments; not all requirements and capabilities can be made explicit within PMP)
	Quality	Medium (data quality in different systems can be improved, this hampers quality of the response)

When analyzing the introduction of PMP in the IBM organization, it can be characterized as a top-down process, with the aim to increase (global) transparency. Although this approach has a number of benefits, the introduction and adoption of the system has not been flawless. One of assumptions behind the system is that knowledge and experience can be made explicit (codified) and stored in a system. However, this requires a certain level of standardization on skill levels and experience, which will not always align with all types of work and experience. This can lead to shadow systems, like the *who-knows-what database*, which is used within IBM MTS (case 2). Since knowledge and experience changes quickly, it requires a lot of time and discipline of all users of the system to keep their profile up to date.

One of the key requirements for systems like PMP to work and be adopted is a high level of data quality. If data quality is not sufficient and information cannot be trusted, users will distrust the IS. This has a negative effect on the adoption and use of the system, with (informal) turnarounds as a result (Quote 1-8). The case shows that it is difficult to break such a negative spiral. Data quality partly depends on the system architecture. Certain activities, like internal projects, were not included in the design of PMP. And certain types of skills such as soft skills are difficult to store in tools such as PMP. This reduces visibility on the availability and skill levels of people (Quote 1-2).

Data quality brings us to a number of more fundamental challenges in the use of PMP. There are certain costs involved in the use of PMP. People have to fill in their expertise and keep their availability up to date. Especially if there are no direct consequences to the improper use of the system or the users do not feel an urgency to keep their data up to date, data quality levels will remain low (Quote 1-8). In the IBM knowledge management systems, this has been solved by coupling salary and promotion opportunities to the level of knowledge sharing in *Knowledge DEAL* (see Quote 3-9). Besides a lack of urgency, people can also have other reasons engendering a lack of transparency. For instance there can be political reasons to do so. Some people do not like to be managed and might use the system strategically, for instance to look for interesting opportunities, but selectively hiding their availability.

One of the reasons that can explain the difficulties in the adoption and proper use of PMP is (lack of) business-IT alignment. The case shows that top-down initiatives like PMP tend to yield alignment at the managerial (strategic) level, but run the risk of lack of alignment on operational (user) level (Quote 1-11). Insufficient communication and involvement between corporate IS and local users can be one of the reasons for such lack of alignment. People are well aware how to implement IS in a client organization, but it appears that it is difficult to practice what you preach (Quote 1-10). The PMP system most probably will never reach visibility and data quality levels of 100%, so human knowledge and interaction remains an important element in the resource deployment process.

6.4.3 Case 2: IBM Maintenance & Technology Services

Introduction

Maintenance & Technology Support (MTS) is part of the Global Technology Services (GTS) organization and one of the oldest service units within IBM. MTS is responsible for pro-actively and reactively supporting hardware and software of IBM and third parties. MTS can be seen as the insurance policy for customers, who have bought a contract with IBM for hardware/software. Services are provided for a wide range of customers ranging from large mainframes to checkout systems for retailers. MTS is organized per product group and has its own capacity pool of employees. About 70 technicians are employed in the field to provide on-site support. MTS has its own unit, which provides direct support in the use and development of IT. The Strategy, Process and Innovation unit (in short SPI) employs 16 people. SPI is responsible for compliance of MTS processes (to the global IBM standards) and process innovation (via IT). The MTS organization is an incident driven organization. Historically, IBM MTS works primarily on reactive, response-time-based contracts. The way the MTS unit is managed, is closely related to the conditions (Service Level Agreements) which are defined in the insurance contract. This means a certain level of business agility performance is required to respond to disruptions or problems, within a predefined time-window previously agreed to with the customer. In the past few years, MTS takes increasing responsibility for the availability of hard- and software, which leads to a more pro-active approach and response. However, in contrast to outsourcing, the customer remains owner of the hardware and software and remains responsible for the operations. IBM MTS helps its customers to become more agile (i.e. increase response speed to disruptions and external threats). IBM MTS is focused on improving the agility of both its customers and itself.

Business agility need

Highly unpredictable events in the environment of customers can disrupt their processes and machines. Such disruptions require adaptive agility from IBM MTS. An example of an external unpredictable event with high urgency and impact, was the financial crisis and the problems with IceSafe bank in 2008. IceSafe bank, which had become popular due to its high interest rates on savings accounts, suffered financial problems in the course of 2008. In September 2008, Icesafe bank could no longer fulfill its financial obligations, and from one day to another, clients could no longer access their internet savings accounts via the web. This led to significant panic among customers of IceSafe and other banks. They all wanted some kind of assurance that their money was still safe and could be accessed via the internet. The first sign that there was a problem was the fact that the Icesafe website and account information was no longer accessible for clients. This led to peak load traffic on bank websites. One of the customers of IBM MTS had a problem with accessibility of their own website, which required immediate response of IBM MTS. A redundant machine managing web traffic normally ran at 50% of its full capacity; this percentage was distorted during the crisis. As a result, before the customer alarmed IBM MTS, IBM already was notified with an alert from the machine. This issue was escalated worldwide within IBM, since this was an urgent high impact problem, which might occur for other banks as well. Since access to the banks' website was directly coupled to the company image of the bank, there was a high need to guarantee access and provide services as normal. IBM MTS sent two technicians to the customer's premises, who continuously monitored the functioning of the machine. The response time was short (within a few hours on a Friday afternoon), and the service continued through the weekend and weeks after. This preventive support service was provided for about two weeks.

Sensing, responding and learning

The business process of IBM MTS is highly structured. Figure 6.7 provides an overview of the core sensing, responding and learning activities and the supporting Information Systems and Tools used by the MTS delivery organization**.** IBM MTS uses a combination of local IT (shaded dark) and global (corporate) IT (shaded light). Based on the empirical research, ten activities were identified. Three activities (5, 7 and 9) are (partly) sourced from external partners. The Retail Coupled Call Management System (RCMS) and the RETAIN knowledge management database are the two core IS that support the MTS delivery organization.

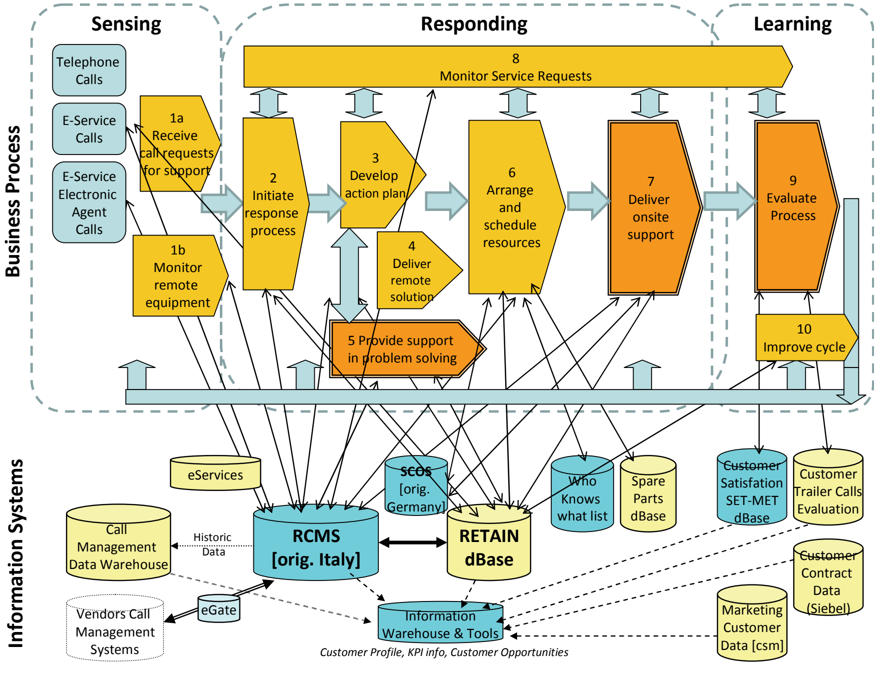

Figure 6.7 - Service delivery business process and core Information Systems and Tools IBM MTS (adapted from source: IBM, 2008 (D-9))

The MTS process, in most cases, is triggered re-actively on the basis of a call by the customer. Calls can be registered and entered via phone (and the IBM helpdesk) or directly, electronically, via the web (E-service calls). In addition to a reactive response to customer calls, MTS employees (per product group) also continuously monitor logs or bulletins of hardware and software of their customers (activity 1b). These logs are posted somewhere (on a server), where they are monitored from time to time. Monitoring relates to the usage of customer's infrastructures, the development in terms of workload, statistics, code levels and errors. This can lead to pro-active actions (pro-active initiated service requests by MTS staff) for the customer to prevent outages or a reactive response in the event of a disruption.

One step further is the usage of electronic service agents installed on the customer's machine, which can pro-actively alert IBM MTS in case of (expected) disruptions. This information is pushed to IBM MTS in real-time. However, it is not possible to move to adopt a pro-active response model for every type of disruption this depends on the type of disruption. Pro-active response is possible by analyzing how machines are behaving, for instance with regards to memory and storage usage. There are programs (software agents), which run on the machines that monitor the machine's behavior on a number of aspects. The course/trend and the frequency are measured and compared with benchmark figures, which have been defined based on previous practice and data from the factory. If the threshold is passed, the service processor calls out to the IBM MTS, which then initiates the RCMS call process in the front office. Then, automatically a call in the RCMS system is placed in RETAIN.

Internal sensing can also initiate the MTS process. As an example, IBM can discover a bug in the micro code for their equipment. This initiates the MTS process, which starts with an internal check in inventory lists to find out which customers use the specific equipment. This is followed by the normal response process, where the involved customers are contacted to prevent possible outages.

The response process starts (activity 2) at the IBM helpdesk (request receipt centre), which receives the service request (call), validates the call (who is the customer, what are the contracts), collects relevant data and then routes the call to the next phase of the response process. The severity of a disruption (impact for the customer) in combination with the SLA determines the order in which calls are handled in the different process steps (with work queues) and the speed in which disruptions are handled.

The next activity (3) is handled in the front office, which consists of product specialists who call the client regarding the disruption. They analyze the problem and develop an action plan, which includes the required skill level(s) to solve the disruption. Depending on the severity (alarm level) of a disruption and the external circumstances, a specific response is taken. If it is a high severity disruption, which requires non-standard actions (with extra costs involved), this is escalated to the management team. They discuss how to respond and set out actions. The decision on a specific response is based on previous knowledge stored in RETAIN and tacit knowledge of the people.

"Maintenance and technology support is a business where you need to have a gut-feeling for (the business of) the customer to make a proper estimation of the possible impact of a disruption for the customer. The decision to respond in a certain way and decide upon the urgency is partly based on information which is available within IBM databases and partly based on the tacit knowledge and experience of the person, who is responsible for the customer (the product or customer service manager)." ***Quote #2-1, manager IBM MTS Benelux***

Sometimes the front office can directly deliver a remote solution, without routing the call to other departments (activity 4). For known errors (incidents) the knowledge database RETAIN is used. RETAIN works as a decision support system containing known errors and their possible solutions. Usage of RETAIN empowers people to find solutions and make decisions. For standard problems standard solutions can be found in RETAIN.

If the problem is customer specific or unique and the 1st line of support cannot find a solution, the call is redirected to the back-office (2nd line support), which is often located outside the Netherlands (activity 5). The back office consists of the development labs, where super specialists are employed. Usually, they try to recreate the disruption at their site in a test environment in order to analyze it and find a solution. If 2nd line support cannot find a solution for the problem, the call can even be further redirected to the original developer of the machine. Switching between different levels of support is relatively quick and easy. Having these direct connections makes IBM MTS very agile in comparison to its competitors.

If the problem has been identified and the action plan is in place, the call is redirected to the resource management centre, part of the field delivery organization. Depending on the action plan, the resource management centre plans technician(s) for field service delivery and orders spare parts (if required) (activity 6). Replenishment of (spare) parts has its own logistics systems and onsite support by IBM staff. IBM has systems, which track the availability and location of (spare) parts or machines worldwide. In these databases employees can search by part or machine type. People in the resource management centre depend on IT and their personal relationships to organize the field service delivery process.

The field delivery organization sends out technicians who go onsite and are at that moment the hands and ears of the front office agent (activity 7). A portion of the services of IBM MTS are sourced from external partners. This relates to field service delivery. IBM MTS is moving towards a multi-vendor approach to reduce dependence on one partner and to stimulate competition among vendors to provide the best service-price combination.

However, this increases complexity. Vendor performance is measured and is used in the billing phase including bonus arrangements.

"In case we support machines from another vendor, we always make sure that we have the relationships with an authorized service provider (partner), who in their turn has the relationship with the labs of the vendor. Such relationships are arranged on a contract basis. The slogan we use is "We serve non-IBM products like they were our own". Such partners can easily be connected to RCMS and RETAIN with a login-password via the Internet (which are generated via the RCMS and RETAIN system). Their data access rights are more restricted, compared to IBM internal users." ***Quote #2-4, field service manager MTS***

IBM has a security system that can be reconfigured and customized to provide access to certain parts of the IBM intranet. This enables a quick-connect to (new) business partners.

"If there is an arrangement and contract with a business partner, the next day they can be on IBM's system. The reconfigurability of these systems and central governance on access enables this quick-connect capability. Further if I want to work with a customer I can make a database (in Lotus Notes) or a shared workspace, which is set in a separate working space, and provide my customer access on the spot." ***Quote #0-2, Consulting partner, IBM Benelux***

People within *monitoring and control* manage and monitor the overall process and continuously compare service level agreements (SLAs) with the actual progress in the call management process (activity 8). Thus people responsible for the SLA contracts can use the MCMS system to manage the progress of the SLAs.

"The whole service delivery process is structured to a high degree. If you don't structure it in such a high degree, you lose oversight and it becomes a mess. In exceptional cases where there is a high urgent situation with a customer, I make sure it is quickly passed on via the different steps of the service delivery process. Often I have already a person to be assigned to such a call in mind. I still use the structured process steps, but I use personal communication to inform the other people in the service delivery process that an urgent call is coming, so it can receive the priority it needs and be handled quickly." ***Quote #2-5, field service manager MTS***

The availability of resources is one of the critical aspects in the whole process. IBM MTS needs the flexibility to increase or decrease the number of people to work on calls. IBM MTS now works on the *Follow the Sun concept*, where Japan starts, followed by Europe, then the US and then again Japan for support in the non office hours. This enables 24x7 support. Requirements for such a concept to work are shared standards, alignment between different units operating procedures, shared organizational memory and shared language (English). This *Follow the Sun concept* process is only applicable for the Front-office/Back-office support structure.

For learning purposes, IBM MTS uses knowledge databases such as RETAIN around the globe. People are motivated to add knowledge to these databases. The information which is stored in RETAIN contains documentation on the customer and information from past performance and disruptions. IBM MTS makes internal customer account plans. These plans form the basis for the commercial customer and also provide insight on the role of IT for the customer. The customer defines the urgency of specific (potential) disruptions. Besides contacts with customers, employees of IBM MTS team up with customer teams from IBM, for instance from the IBM product divisions. IBM MTS employees need alignment with their counterparts in the other IBM departments, to respond quickly as a team towards the customer.

"In the past many escalations of disruptions which came from anyone within the IBM organization, were done via the division director. The reason for this was the lack of knowledge and connections within other departments of IBM on who to contact within IBM MTS. By having MTS people participate in the customer account teams, this problem has been reduced and communication paths have become more clear and agile. " ***Quote #2-6, manager IBM MTS Benelux***

The MTS process depends to a large degree on the experience of its employees and the network they can mobilize to solve disruptions.

"....Real agility depends on people: the knowledge they have and the network they have to quickly connect with. .... We stimulate customer service managers to develop their (human) network. This relates to the contacts with customers, the internal MTS organization which needs to be mobilized for an agile response and the contacts within other IBM departments. .... " ***Quote #2-7, manager IBM MTS Benelux***

IBM MTS tries to engage their customers in the sense-respond-learn loop. Depending on the agreements with the customer, quarterly or monthly feedback meetings are organized to evaluate the service delivery process and come up with improvements collaboratively (activity 9, 10). Also the SLA contracts are discussed in these meetings. After a disruption has been solved, IBM MTS and the customer evaluate and discuss how the response was organized and how things could have been organized to remedy the unexpected situation even quicker. MTS analyzes what has been delivered (SET) and how this has been achieved (MET). The resulting actions are stored in the SET-MET database, which feeds back to the service delivery process for improvements.

In addition to these customer evaluations, which are done by IBM MTS themselves, customer satisfaction is measured by an external partner at the request of IBM. As part of this effort, a selection of calls (for hardware closed calls and for software open and closed calls) is forwarded to an external organization. This organization approaches the customer to evaluate their satisfaction with the response to the call and the service delivered by IBM.

This generates data on customer satisfaction, which is stored in a worldwide database. Based on the outcome of this call process, a customer satisfaction index is created. This creates a continuous feedback and learning process, with the aim to improve the process in the future.

IT capabilities support for sensing, responding and learning

The whole process of dealing with disruption calls is highly standardized and organized via a work flow management system, RCMS (Call Management System), which couples different persons via a post bus-like facility. All process steps, actions and outcomes are logged via this system. Formal reports for customers can be made based on the logging data that is stored in this system. All customer KPIs or SLAs are monitored via this system. If KPIs are not met or a customer has a complaint, a new procedure starts with its own tools and managers who ensure that the organization takes the required measures. If IBM senses impending complaints, IBM MTS makes a pro-active complaint and initiates this procedure itself. RCMS is also used to support local planning of field service engineers. RCMS provides insight in (over)capacity of IBM MTS staff. If escalation is required – like support from the back office - the call is copied to the knowledge database RETAIN, which can be accessed worldwide. The call management process for software support only uses RETAIN. In RETAIN all solutions are stored, linked to call numbers. This database contains more than 25 years worth of data. The RETAIN system was developed by IBM. RETAIN also works as the communication tool between front office and back office via a mail-function coupled to entries in the database. The quality of data within the systems is high, ranging between 99 and 100% accuracy. IBM MTS is highly dependent on the IT systems and data quality, especially in case of responding to a high urgency disruption. Customers are provided transparency and insight with regards to the status of their call via an electronic interface that provides a window onto RCMS. This is, however, only in cases where the customer has decided to report disruptions electronically (i.e. initiate the call management process) or use electronic service agents. This reduces the number of phone calls to the helpdesk of MTS a lot. If the customer seeks support via telephone, the customer has no insight in RCMS. IBM MTS managers have concrete targets to increase the level of electronic services.

The field service delivery technicians can access RCMS and RETAIN via their Personal Digital Assistant (PDA) with two-way communication. When they start with a customer on a call, this is confirmed via the PDA in RCMS. When they have finished a call they close it via their PDA, after which they can move on with the next call in their work queue. This way there is a continuous stream of feedback built into the process. Via the PDAs, IBM MTS has transparency on its resources and people permitting those in the field to be reached quickly.

IBM MTS is part of the old IBM organization. This means that certain systems and processes have been optimized and used over the past 60 to 70 years. Most of the IT systems are older systems with a new (web based) interface, which have been expanded during the years with a variety of interfaces. Making changes to these systems is not easy or cannot be done quickly, since these systems are used globally and are interconnected.

"RCMS originally was developed by IBM Italy. This system was developed more than 20 years ago. During the years all kinds of additions were added to the system, like Service Level Agreements. The current system is very large and complex, what makes it complex to work with. It takes quite some time before information is passed on from one department (queue) to another. It runs on a platform called VM, which increasingly becomes less supported with only few people remaining with in-depth knowledge on how to support it….." ***Quote #2-8, field service manager MTS***

"The IT which is used by the MTS delivery organization has become very complex during the years. Therefore more uniformity is required to be able to change certain parts in the future and exchange data with other units. For instance the RCMS system is a mainframe application, which is character oriented and out of date with regards to its look and feel. The replacement of RCMS by another tool has been postponed. The main reason is the implementation differences between local RCMS tools, which are quite different. This makes it very difficult to replace these local systems with one new (central) system. ….. We are working on some level of synchronization of data structures, to be able to come up with measurements (KPIs). These are required to be able to compare between different (country) organizations.". ***Quote #2-9, MTS manager SPI***

MTS is unique in the IBM organization in the fact that it has its own unit (SPI) to support the use and innovation of IT. This makes it possible to adapt IT more closely to local demands and requirements. The MTS Benelux process is compliant with a worldwide Global Services Delivery Process definition (GSDP), which is a compulsory high level process model set by IBM corporate. This model states how IBM delivers service, anywhere in the world. Any system within the IBM network must comply with standards set by IBM corporate, like the GSDP standard. Tools need more in-depth certification, if these are used between departments or when the tool provides input to financial results. The actual implementation and conversion of process standards into IT, like the choice for a specific call management system, is made on a local (country) level. A project has been initiated to synchronize the different systems and procedures in the different countries and come to one standard.

SPI has a sub-team, which is responsible for innovation and development of tools on top of the existing (corporate) IS. It is custom within IBM that a lot of applications are developed decentrally – close to the local market or business. If a certain application works well locally and departments in other countries are enthusiastic about it, the local unit is assigned to develop it further and roll it out to other countries.

"All tools that we develop locally are goodies on top of what already exists. The core IS (RCMS and RETAIN) are redundantly available and will always need to work. For the local tools the business does not stop, if they do not function. It is just inconvenient. For instance we developed a notification that a systems manager receives, in case a customer's system is down. If this does not work he will still respond, only this might take a bit longer. Another tool which has been developed by SPI provides management information and KPI measurement. This tool compares contract terms (from the contract system) with actual realization (from RCMS); also it indicates where any deviations from contract originated. This helps the learning process and provides input for improvements in the process. Another tool that we developed is used to spot customer opportunities in contracts, e.g. end of contract term. You could say that the local tools provide an extra layer of agility on top of the corporate IS." ***Quote #2-12, MTS manager SPI***

The SPI unit built another tool – an information warehouse – to create a more comprehensive view of the MTS customer. The tool combines data from different data sources and gives the MTS manager more contextual information on the customer relationship. The MTS manager and lifecycle managers can build queries themselves on the data warehouse. This tool empowers managers in their decision-making and helps to increase agility.

"The MTS IT development team (SPI) had to build an information warehouse to extract data (via interfaces) from different databases. In the past I was dependent on others to deliver me certain data that I need. Now I can access the data and make queries when I need it. … ***Quote #2-13, field service manager MTS***

"Since customer data is stored in different systems, a good overview on the customer was lacking. Questions like who is this customer, what kind of services do we offer to this customer, how many disruptions did this customer have last year and did we receive any complaints from this customer used to be very difficult and time consuming to be answered. SPI developed a query tool to get such a customer overview. This tool is now used within MTS Benelux and will be rolled out further in Europe. There is also interest on global level, however one of the difficulties are the differences on detailed level between countries, with a lack of uniformity on data structures." ***Quote #2-14, MTS manager SPI***

SPI is changing its approach towards tool development, investing more time and money in the initial requirements and development phase. This way, a more structured approach towards incorporating agility in the design of IT is pursued. A certain level of up-front agility is embedded in the design of new tools. In later stages, this has important agility benefits and avoids the need to make expensive and time consuming local adjustments.

"For new tools we actively look for a possible wider usage beyond usage just within MTS Benelux. We want to build the coding/tooling as is, with as much universal applicability as possible. By taking

more time in the basis, we develop a more long-term strategic tool, in which (re)configuring it for other units and countries is much easier. In the beginning this means more overhead and costs, but later it is much more easy to configure it for other units. This way we move from ad-hoc solutions to more structural solutions. Also this can reduce the number of similar but different tools in different countries, which each need to be build and supported......" ***Quote #2-16, MTS manager SPI***

Business agility performance

Based on the empirical evidence we analyzed, business agility performance of MTS to respond to a disruption, is based on four change proficiency metrics (Dove, 1995, 2001). *Response time* scores high (relatively short response times). The use of IT helps to quickly respond and connect different departments and people involved. IBM MTS is working on improvements in its response timeliness by enhancing its sensing capabilities, for instance via the use of agent software installed on customers' equipment. By increasing its sensing capabilities, response can move from a reactive mode to a pro-active mode. This has clear effects on business agility performance and also indirectly on business performance.

"The moment that you become pro-active and know that certain problems will emerge, you can gain efficiency benefits. For example shipping parts or machines via the regular procedure is cheaper than via the urgent procedure (using courier and air freight services). If you can plan the deployment of personnel in advance, it is also cheaper than making last minute use of staff to reactively respond to a disruption (with higher personnel costs for the non business hours). In this respect we try to convince our customer to move towards the use of e-services. This applies both to the initiation of calls but also to the facilities of their systems, which can pro-actively alert for possible problems based on embedded intelligence." ***Quote #2-17, manager IBM MTS Benelux***

Overall, *response ease* (costs) scores medium. For some types of disruptions, response can be easy. This relates to disruptions, which can be solved remotely or where solutions can be quickly delivered, based on the available explicit knowledge (cause-effect relationships on errors and solutions) in the IT containing organizational memory. Some disruptions are more difficult to solve requiring back-office support and tacit knowledge from experts working in the original equipment factories. In such cases response ease can score low. On the other hand, *Response quality* scores high. All processes are continuously monitored and coupled to SLAs, supported by IT. This supports predictability and timeliness of the response. *Response range* scores high. MTS supports both hardware and software disruptions, both small and large disruptions, up to significant calamities (which are forwarded to the BCRS department). MTS is also extending its scope of support into a multi-vendor setting.

Analysis

IBM MTS runs a well structured process, which has been developed over the years. The need for business agility is relatively low, since the business (model) is rather stable. Most problems that can occur with the equipment of customers are well known and each one has their own known response process. This explicit knowledge is stored in structured databases (RETAIN). There is uncertainty on the timing and location of disruptions, which are relatively difficult to predict. This means sensing is an important challenge for MTS. The core information that MTS needs for sensing and responding is stored in different global and local systems. Learning is used to keep existing sensing and response capabilities up to date and improve where possible. Table 6.3 provides an analysis of the case study based on the case evaluation framework.

Table 6.3 – Analysis case 2 IBM Maintenance & Technology Services

Variable	Sub-dimension	Case 2
Event	Event Type	Disruption of customer's equipment (Icesafe)
	Event uncertainty	Time/location uncertainty
Business agility Need		Business Efficiency Agility
Business agility Sensing	What is sensed?	Data from customers (via phone, eServices)
	How is it sensed?	Via helpdesk and based on monitoring remote equipment via agent software
	Critical success factors	Sense-making: development and monitoring of threshold values in data in order to identify abnormalities in data, that can change response from reactive to a pro-active mode
	Enablers and inhibitors	Enablers: electronic services and agent software Inhibitors: possibility of sensing overload
	Maturity	High
Business agility Responding	How is responded to the event?	Develop a response (solution) and deliver solution with support from partners, standardized in global GSDP process definition and based on agreed SLAs
	Critical success factors	Tacit knowledge and experiences of product specialist who develops the action plan Short escalation lines in case of high severity disruptions Human relationships (social capital) with other IBM units
	Enablers and inhibitors	Enablers: knowledge database RETAIN, tracking systems for (spare) parts and field technicians, relationships with development labs and external vendors, flexibility and availability of people resources, electronic services
	Maturity	High (only relatively low maturity on quick-connect and partnering response design)
Business agility	How is learned from	Regular feedback meetings with customers Based on the SET-MET database the customers' process

Variable	Sub-dimension	Case 2
Learning	the event?	cycle is improved and incident response process in RCMS and RETAIN is improved for future responses. Customer satisfaction is measured via trailer calls. Vendor performance is measured.
	Critical success factors	Codification of targets and realization in all process steps Regular feedback of customers.
	Enablers and inhibitors	Enablers: IT, customer satisfaction index
	Maturity	High (only low maturity on external information dissemination)
Sensing IT capabilities	IT capabilities	eServices (agent software and eServices) Data warehouse
	Maturity	High
Responding IT capabilities	IT capabilities	RCMS software for call management and process monitoring (local IT) and RETAIN as knowledge management system, Spare Parts dBase and eGate to connect to external partners' systems (corporate IT)
	Maturity	High
Learning IT capabilities	IT capabilities	Local IT (Who knows what list, customer satisfaction SET/MET database, information warehouse) and Corporate IT (RETAIN, Customer Trailer Calls evaluation, CRM (Siebel), Call management data warehouse)
	Maturity	High (only customer learning & feedback scores low)
IT strategy	Enterprise architecture	Complex architecture with interfaces among different local and corporate systems; data sharing local, partly global; Overall maturity level: business silo / standardized technology
	Knowledge management	Focused on codification of event-cause-solution relationships per customer and equipment type
	IT-business alignment	Medium SPI unit increases BITA, usage of global GSDP model, agility incorporated in design of new IS (via versatility)
Business Agility Performance	Timeliness	High
	East (cost)	Medium
	Range (variety)	High (hardware, software for multi-vendor equipment disruptions)
	Quality	High (response is continuously monitored, builds upon previous expertise and highly experienced staff)

The MTS case illustrates some of the challenges in the move from internal agility to external agility, where IBM involves its customers and partner(s) as part of its own organization (i.e. customer agility and partnering agility). As a business, you can be very agile. As a business involves other organizations in sensing, responding and learning, the business needs to make sure that they also become (more) agile. In the end, the weakest link can reduce the agility performance of the whole system. This creates certain dependencies and risks and requires joint agreement on an approach towards agility, costs (sharing), standards and specific IT, such as the capability to quickly connect, disconnect and collaborate. A part of this inter-organizational agility is kept close to the primary MTS organization, for instance by using agent software (for monitoring and alerting) on customers' equipment and using remote diagnostic and problem solving. MTS is gradually moving to an external agility approach and exploiting customer agility in order to increase sensing and become more pro-active. For instance the use of self-service environments to register calls and monitor the response process by the customers themselves is an example on the use of customer agility for data acquisition and response monitoring. One step further is the introduction of embedded intelligence in the machines of customers and real-time network connectivity to IBM for real-time pro-active sensing. MTS tries to convince its customers to change to this customer agility approach, since it can bring benefits to both the customer and IBM. In this way, IBM can provide its customers with higher levels of responsiveness at lower costs, if they participate in this customer agility approach. On the partnering site, IBM makes agreements on process standards, service level agreements and performance monitoring in order to facilitate partnering agility and to ensure overall business agility performance stays within the contractual arrangements set with the customer.

This case illustrates some challenges for a global organization such as IBM with regards to the enterprise architecture, the governance of its information systems and the alignment between business and IT (BITA). Businesses need to think about how they govern their processes and IT in order to remain stable and efficient at the global level while keeping agility at the local level. This is the tension between the use of global standards and the need for decentralized local customization. *Architectural alignment* relates to alignment and connections between IT components and the use of standards in that respect. The IT infrastructure can contribute to the speed of action by providing real-time and remote access to corporate information and knowledge resources, as well as improving the timeliness of management information (Strader *et al*., 1998). The most important IS (RCMS) was developed more than 20 years ago. During the years, all kinds of additions were added to the system, which makes it large, complex and relatively slow. Migrating to a new system is challenging, given the embedded complexity and coupling to other systems and databases, such as RETAIN. This hampers the sharing of information among different MTS units. Adapting the IS in the event of new customer and regulatory demands is challenging, which hinders the agility of MTS.

IBM works on architectural alignment by setting global standards for IT, processes and data definitions. The worldwide Global Services Delivery Process definition (GSDP) is the most important standard. This is a compulsory high level process model set by IBM corporate. This model states how IBM delivers service, anywhere in the world. Without such global standards it is unfeasible to compare KPIs and share data. IBM employs IT architects on project teams and uses a formal compliancy process (activity of the SPI unit) to manage the standards. A challenge is posed by local IT such as RCMS, which can deviate slightly from the global GSDP standard. IBM is moving towards a model incorporating more up-front architectural alignment and agility in the design of Information Systems (see Quote 2-16).

Data alignment relates to the corporate data architecture and the balance between corporate needs and local needs for data and business intelligence. One of the key challenges in data alignment is the alignment of different (local) data formats and procedures. This has implications for data quality and data transparency. The MTS case illustrates the challenge to integrate different (stovepipe) systems and local databases, which are typical for any large, global organization such as IBM. Since data is spread among different databases and sometimes in different data formats, data sharing between departments is difficult. Real agility becomes possible, when contextual information is provided to data, which comes from different sources (Prahalad *et al*., 2002). The case shows a number of examples, where higher levels of data transparency and the possibility to query and combine data from different sources (local and corporate databases) can increase both adaptive agility and entrepreneurial agility. An example is the alert tool, which combines data from the agent software, the RCMS system and the customer contract terms. In case a customers' system is down, with an affect on the SLAs as set in the contract, an alert is send to a systems manager to initiate a call (Quote 2-12). Another tool is used to combine and query different databases (Siebel, RCMS, customer trail call evaluations) to get an extensive overview of the customer relation. This is very useful in the sensing phase for spotting customer opportunities and the learning process to improve the customer relationship (Quote 2-14).

Social capital in terms of employees is an important factor that enhances business agility. Having a network of relationships with other people in internal IBM departments and external partners supports sensing, responding and learning (see Quotes 2-2, 2-3, 2-4, 2-6, 2-7). This (informal) connectedness (i.e. the personal relationships and network) is an important element in sensing, responding and learning. These results were also found in a study by Jansen *et al*. (2006), who found informal coordination mechanisms (i.e. connectedness) often have more importance than formal coordination mechanisms for developing either exploratory or exploitative innovation. Bridging social capital moderates the relationship between IT capabilities and business agility. People use their *social capital* to mitigate a possible lack of IT agility. People are accustomed to the use and (lack of) speed of the RCMS system, but also (informal) networks and their personal relationships in the event that real agility (speed) is required (see quotes Quotes 2-7, 2-13).

6.4.4 Case 3: Jamming and IBM Centre of Excellence for Water Management

Introduction

Innovation is one of the top priorities of IBM. In the move towards higher value services for its customers, IBM needs entrepreneurial agility to shorten the time to develop new ideas and come up with new business models. This case study describes the use of Jamming technology as a structured approach to mobilize and manage knowledge while improving the idea generation process through mobilization of collective intelligence (i.e. the wisdom of crowds). The case also describes how IBM used the outcomes of the Innovation Jam to set up a new unit, which is exploring the market of water management and experimenting with new business models.

Business agility need

In the changing marketplace IBM explores new models for shortening the time to develop new ideas and for extending its response range to deliver new value to its customers. The Value Jam and Innovation Jam have been successful mechanisms to tap into the corporate creativity. Jamming is a way of collaboration via a moderated group of interlinked bulletin boards and related web pages, where ideas can be posted and discussed. The infrastructure for jamming is organized for a group of 10,000 people or more and can be used on a global scale. This approach is based on mobilizing collective intelligence (i.e. the wisdom of crowds). The results of these Jam sessions provide direct input for the CEO and management team of IBM. IBM used these online brainstorming sessions to mine for new business opportunities in 2001, to exchange ideas about good management in 2002, and to discuss IBM values in 2003. The use of such innovative IT is an important enabler for innovation and entrepreneurial agility in IBM.

"The usage of advanced IT tools makes IBM very agile and helps to pro-actively respond to innovation opportunities. You don't see many organizations where the highest managers can be reached via chat. What happens now within IBM will be on the ground in the Netherlands within four years time." ***Quote #3-1, Business development*** *Executive Centre of Excellence for Water Management*

Sensing, responding and learning

Figure 6.8 describes the business process that relates to idea generation, business development and project execution for IBM in general, and the IBM Centre of Excellence for Water Management in particular – as a follow-up of the Innovation Jam. We distinguish sensing, responding and learning activities and the supporting Information Systems and Tools used by the IBM Centre of Excellence for Water Management. Based on the empirical research, eleven activities were identified. Four activities (1, 6, 7 and 10) are (partly) sourced from external partners. The main activities part of the Jamming process and the business development process for the IBM Centre of Excellence for Water Management is the focus of the following subsection.

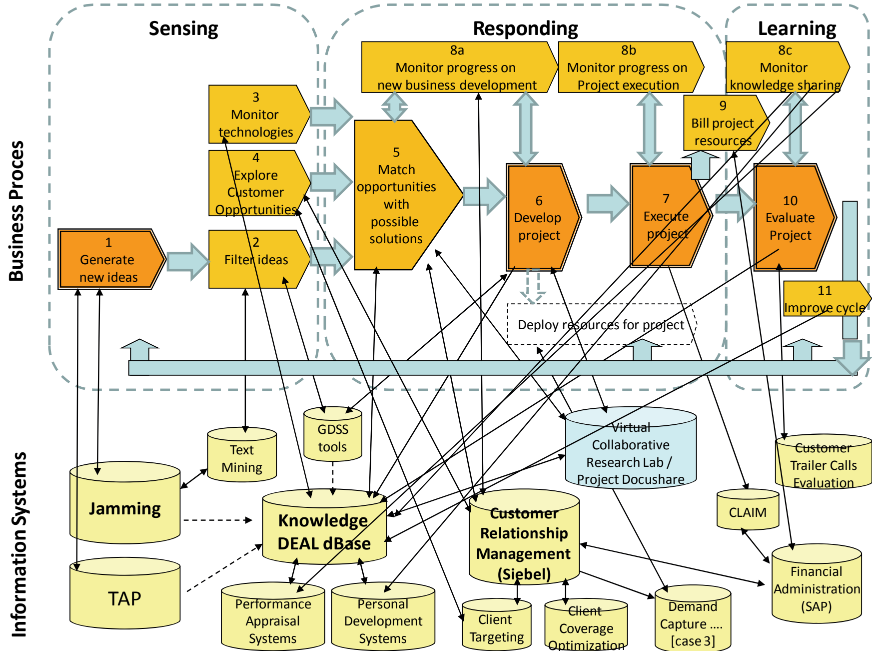

Figure 6.8 - Idea generation to project execution business process and core Information Systems and Tools IBM Centre of Excellence for Water Management

Jamming

In 2006 IBM used jamming technology for the first time with external people in the Innovation Jam (activity 1). In July and September 2006, IBM CEO Palmisano launched the Innovation Jam. In addition to IBM employees, participants in the Innovation Jam consisted of representatives from universities, partners, and customers. The Innovation Jam was organized as a unique 3-day event, where participants could brainstorm and post ideas under four overall themes, one of which was a better planet. IBM selected 67 organizations (partners and customers) that could participate. Each organization itself selected the people that should participate in the Innovation Jam. In total about 150,000 people from 104 countries participated in the Innovation Jam, which made it the largest online brainstorming session ever. This led to more than 37,000 unique ideas. The Innovation Jam in 2006 was divided in two sessions (one in July and one in September 2006) for 72 hours each. The first Jam session was meant to brainstorm and generate ideas, linked to 25 IBM identified clusters of technologies. This first phase was followed by an evaluation period, in which top ideas were selected and refined by IBM senior executives and professionals into 31 cluster themes ("Big Ideas"). This was followed by the second phase of the Innovation Jam, where the themes were refined and solutions and opportunities were discussed based on three criteria: uniqueness, potential impact and timeliness. This jam focused on how to realize the ideas. Participants could click to a separate site, where they could work on business plans for key ideas using wikis.

In November 2006, ten ideas from the 2nd Innovation Jam were selected by IBM to receive funding of 100 million dollars for exploration and development in collaboration with external partners. The Innovation Jam initiated investment programs in emerging markets, such as Africa. The outcomes also underlined the need to improve corporate social responsibility. One of the 10 ideas was *big green innovations*, which was later split into carbon management, energy management, and water management. Many reactions and ideas which came out the Innovation Jam were related to water management issues. Previously, no one in IBM had discussed this topic as a potential large business opportunity for IBM. The Jam revealed that IBM could make a major contribution to this field (Bjelland and Wood, 2008). As a follow-up to the Innovation Jam, IBM needed to deploy entrepreneurial agility to seize possible opportunities and convert any good ideas into marketable products or services.

Centre of Excellence for Water Management

As a follow-up to the Innovation Jam, in February 2007 a brainstorming session, with about 30 people from IBM, was organized to analyze the implications and opportunities for IBM in relation to water management. Since a number of Dutch firms take the lead internationally in working on water management related projects, such as Arcadis (New Orleans) and DHV (Yangtze River), it was logical to collaborate with these partners and set up a competence centre on water management in the Netherlands. This center was tasked with exploring the market and developing knowledge and contacts for use worldwide. The official inauguration was February 1, 2008. The timeline of the development of IBM Centre of Excellence for Water Management is shown in Table 6.4.

At the moment [February 2009] over 40 IBM people are involved in the IBM Centre of Excellence for Water Management and all relevant organizations and aspects in the international water sector are involved, such as flood management, water quality, weather prediction, industrial water use, and so on. The Centre of Excellence for Water Management has two main objectives. First, the centre evaluates the opportunities in the market for the water management related business. Second, it provides the different IBM brands and solutions specific to water knowledge. The business culture and processes of IBM Centre of Excellence for Water Management is relatively fluid and the centre explores the possibilities of new business models in collaboration with the external partners.

Table 6.4 - Timeline Innovation Jam and development IBM Centre of Excellence for Water Management

April-June 2006:	Preparation Innovation Jam by a team of people (3 to 4 months)
July 10, 2006	Pre-Jam: Interactive and online material available to help fuel participant thinking and ideas for the jam
July 24-27, 2006:	Innovation Jam (1st round), focused on idea generation
August 2006	Evaluation Period (selection & refinement top ideas)
Sept. 12-15,2006:	Innovation Jam (2nd round), based on 31 cluster themes.
	This jam focused on how to realize the ideas.
November 2006:	10 ideas are chosen by IBM and 100 Million Dollar is invested in the development of these ideas
February 2007:	Brainstorm with a team of 30 IBM people on Water management
February 2008:	Official inauguration IBM Centre of Excellence for Water
	Management in Netherlands (Amsterdam)
2008	IBM engaged in 4 ‘mega’ pilots on Water Management
February 2009:	IBM participates as sponsor and exhibitor on Aquaterra World Forum on Delta & Coastal Development

To achieve its objectives, the centre has three broad activity types. First, people from the centre continuously monitor technologies, which are developed by and available from IBM labs and other organizations worldwide (activity 3). In particular, Google is used as one of the tools for monitoring developments and new technologies worldwide. Additionally and even more important, is the work related to meeting and talking with people during conferences and face-to-face meetings..

The people working in the IBM Centre of Excellence for Water Management continuously have discussions with organizations in the market to explore their problems and challenges in relation to water management and climate change (activity 4). Face to face conversations provide a lot of context which often holds more information than just surfing the web. There have been discussions and meetings with different parties, ranging from governments, transport companies, insurance companies *et cetera*. One of the challenges is that a lot of things are measured via sensors but these sensors do not “speak” the same language making information sharing difficult. However, in the current environment with an emphasis on real-time processes, sensor information is required for engineering firms and knowledge organizations to build models and simulations. Sensor, however, generated significant amounts of data. This data needs to be converted into information. The information, in turn, needs to lead to knowledge. In the end, the decision maker needs to be able to make the right decision, to decrease costs while increasing predictability and quality. This whole process requires information management advice services, which IBM can deliver. Another example of a problem area is the lack of business continuity plans and facilities in relation to water management calamities. IBM BCRS provides such kind of services.

The most important task for the people who work in the competence centre is to deploy entrepreneurial agility by making connections and matching technologies and possible solutions to the problems they encounter (activity 5). As part of this entrepreneurial agility, it is important to quickly connect with and mobilize IBM departments and external partners to derive solutions. This implies a need for building and exploiting the social capital of employees at the Centre of Excellence for Water Management.

“People who work in the centre have a certain degree of knowledge, but certainly are not the in depth experts on a specific topic. More important, they are typical networkers, who occupy the hub positions within IBM. Typically the hubs within the company know how to find each other quickly. They are open to communicate and exchange information inside and outside IBM.” ***Quote #3-2, Business development*** *Executive Centre of Excellence for Water Management*

The whole approach of the Centre of Excellence for Water Management is customer- and problem-driven instead of solution driven. What are the drivers in the environment of the customer? How does this impact their processes? What are the problems? How can these be prevented? In the end this leads to an IT component. IBM Centre of Excellence for Water Management tries to connect various initiatives in the water world. If a specific opportunity is found, workshops are organized with different people from IBM who might have an interest in the opportunity. An initial proposal is then worked out and discussed with the customer (activity 6).

IT capabilities support for sensing, responding and learning

The IBM Centre of Excellence for Water Management uses various information systems and tools to structure the process of innovation and business development from the phase of idea generation through to the phase of project execution and measurement of client satisfaction (see Figure 6.8). In the idea generation and evaluation phase, IT support was highly structured and well developed with tools like Jamming, TAP, GDSS and text mining software.

As part of its innovation strategy, IBM provides its employees an environment where individual people can develop new things or test new things. One of the tools is the Technology Adoption Program (TAP). TAP is designed to match internal innovations with early-adopter employees who are eager to try them out (part of activity 1). Using an IT infrastructure with tools and communication mechanisms, IBM cultivates innovations and ideas that can be converted to revenue. TAP works like a SEND box. Here, ideas about a new technology can be posted. The TAP program also has communities on specific topics. One of the innovations that originated from the TAP program is SameTime. Another example is Open Office, which is completely integrated with the Lotus Notes environment.

"IBM wants to experience itself how new concepts and technologies work (or not), before these are used with customers. Many inventions are used a number of years within IBM. The successful ones are brought onto the market and used in customer projects." ***Quote #3-5, Business development*** *Executive Centre of Excellence for Water Management*

The IBM Centre of Excellence for Water Management uses group decision support software to support idea generation, idea filtering and decision-making.

"In brainstorm sessions with experts often laptops are used with group decision support software. This facilitates collaborative brainstorming, where participants do not know who brings in certain ideas. The ideas of executives are valued just as much as the ideas of employees, which brings a new perspective and democracy of the brainstorm and decision-making process. " ***Quote #3-4, Business development*** *Executive Centre of Excellence for Water Management*

In the business development phase of IBM's Centre of Excellence for Water Management, information technology is relatively less developed and more experimental. IT is used to support the matching of customer opportunities with internal and external expertise, for example via social network analysis tools. IT also provides a supporting role to improve the communication and collaboration among the partners, for example via shared workspaces. This process is less structured, business models are still under development and therefore IT support is developed less, compared to the Jamming process.

"Although innovation is often an unstructured process, people need to force themselves to structure it to a certain degree and set goals. IT helps to structure innovation processes to quite a level of detail. " ***Quote #3-3, Business development*** *Executive Centre of Excellence for Water Management*

The IBM Centre of Excellence for Water Management explores new IT concepts to support and improve the collaboration with business partners and also provide value to its customers in the business development phase (activity 6) and the project execution phase (activity 7). An example of an innovation which has recently been developed is the virtual collaborative research lab, which works like a layered self-filtering model. Different selected organizations (partners) are connected to the web-based virtual lab with the hubs (networkers) of these organizations participating in the first layer of this virtual lab. Customers with a problem can contact the virtual lab -which works like a virtual office – and post a question. This lowers the barrier to find a relevant person or organization. Together the participants who are interested or who can provide a solution then can set up a joint project (virtual organization) for the customer and create a shared project space, with the possibility for chat (connecting different types of chat systems) and wikis. The different organizations and persons (second layer) are then linked to this shared project space. The collaboration environment is intended to be context driven (linking discussions to a specific document for example). Trust is an important aspect for such a concept to be accepted.

"Working in such a concept, where participants can see real-time who is online increases agility and supports quickly linking to each other. The usage of such a virtual organization concept works well in the get to know phase. Making the real deal and discussing what needs to be done requires physical contact. Once the project is running, there is sufficient trust among the participants and the shared project space can be used for communication. The business model for such a virtual organization concept still is not completely clear. Currently there is not an affordable integrated solution in the market that connects chat with document management. " ***Quote #3-6, Business development*** *Executive Centre of Excellence for Water Management*

In the project execution phase, IT support is more mature and more structured via central IS (SAP, Siebel), reporting tools (CLAIM, SAP) and project evaluation tools. The (status of) the acquisition process and closing of sales and the involvement of IBM staff is registered and monitored via Customer Relationship Management (CRM) software (activity 8a). This helps the organization to monitor its portfolio and focus its acquisitions. IT can help to structure business processes and create transparency, which is an important enabler for higher levels of business agility. On the other hand, there is a trade-off between transparency and trust. Higher levels of transparency can obstruct business agility, if applied incorrectly, as the following quote on the use of CRM (Siebel) illustrates.

"Although IT can help to structure the innovation process, innovation remains human work. Success only happens between people who want to work together and trust each other. You can make everything 100% transparent with IT. This takes away all freedom for the individual to handle or manage certain things. There is a fundamental shift from robot thinking and measuring everything to becoming an organic company. This poses a challenge, since it is not clear (yet) what should be the alternative. This is also the case within IBM. As an example, with regards to monitoring via Siebel you get what you want to manage – this leads to so called spreadsheet management. The formula

which is used to measure progress has become leading. You are not only monitored on the number of signed contracts with customers, but also on your pipeline of acquisitions. Therefore managers just fill it in with figures to make their pipeline apparent full, so that they can focus on achieving their target. This way, the whole monitoring has become useless. There is a gap between administrative people who measure progress (from a distance) and people in the field who are actually doing the work." ***Quote #3-10, Business development*** *Executive Centre of Excellence for Water Management*

To support capturing, storing and exploitation of knowledge in the project execution phase IBM makes extensive use of knowledge management tools (e.g. Knowledge DEAL). These tools are directly anchored to the primary business processes. Knowledge (reusable assets) which is generated is stored in Knowledge DEAL. For each project-start the manager looks, whether certain experiences are stored from previous similar projects. When a project stops, it is mandatory for all project members to document knowledge and experience from the project (activity 10). This can be technical solutions, process descriptions, or application code. Tacit knowledge cannot be stored via such systems. This type of knowledge is accessed by linking to the experience of individual people based on their CV. Sharing this knowledge is linked to the personal development and personal performance systems, which measure and monitor to what degree new knowledge has been developed and shared and the degree to which targets have been met. Managers can monitor the degree in which employees share knowledge via Knowledge DEAL (activity 8c). This is taken into account in the yearly performance appraisal of employees, with direct effects on salary and promotion. Sharing knowledge also makes employees known in the organization, which increases the chance to be asked for assignments in line with previously posted expertise. In this way, there are both direct and indirect triggers to enforce usage of Knowledge DEAL. Successful adoption of new IT tools often requires the people who will use the IT tools to change attitudes. The adoption and use of knowledge management tools within IBM also required a change of culture and attitude.

"In 2000 I joined IBM. I became involved in a knowledge management project, which aimed to make people share knowledge in an intellectual capital structure. You could share your knowledge via worldwide databases aimed at specific knowledge or expertise. In those days, these tools were hardly used. People were very much afraid to share their knowledge and experiences. They feared to lose uniqueness and status as an expert. Later on, the attitude towards usage of these systems changed. Sharing your knowledge via such systems became accepted, it strengthened your position in the organization; it improved your visibility and increased the opportunity to be asked for other interesting projects. It took some time for this knowledge sharing concept to be accepted." ***Quote #3-9, Resource Management Leader, Global Technology Services***

The business development executive for IBM's Centre of Excellence for Water Management points to the use of IT as a critical factor that influences whether IT capabilities enable or hamper business agility. Using the wrong IT for the wrong purpose can lead to information overload, which in its turn can hamper business agility.

"My trust in IT is not very high. IT can be an important enabler to a certain level and if applied correctly. However, I see seldom that it is applied and used properly. This relates to discipline, trust in the persons you communicate with, what are your credentials or are you a spammer. There is a high dependency between the social component and the IT component. If one of the two is not right it is hopeless. You need a good mix between the use of IT and the use of your social contacts." ***Quote #3-7, Business development*** *Executive Centre of Excellence for Water Management*

"The most important means for communicating is the chat environment. The chat provides real-time attention. You can decide whether to respond or not. E-mail increasingly becomes a fiasco due to its exponential growth and misuse. However, I have managed and learned to pick out certain e-mail messages from certain people which are important. Also communication via the (mobile) phone increasingly leads to information overload. Often you end in a voice mail. SMS is a good alternative to get some attention." ***Quote #3-8, Business development*** *Executive Centre of Excellence for Water Management*

Business agility performance

Based on the empirical evidence we analyzed the business agility performance of IBM's Centre of Excellence for Water Management (specifically the use of Jamming in the idea generation and idea evaluation phase) based on the four change proficiency metrics (Dove, 1995; Dove, 2001). *Response time* scores high (relatively short response times). The use of Jamming and its supporting tools have helped to shorten the time to generate, evaluate, and record in detail a wide variety of new ideas. *Response ease* (costs) scores relatively low. The use of Jamming is not cheap. It requires a lot of preparation and many people need to be involved in order to make it a success (in the next section we will discuss this in more detail). *Response quality* scores high. With the use of the Jamming technology IBM has tapped into a wide range of expertise. The whole process has been carefully set up to combine the knowledge of Jamming participants with the knowledge of IBM experts and managers, especially in the evaluation of the results. *Response range* scores relatively high. Jamming can be used to tap collective intelligence for different means, as previous Jamming sessions have shown.

Analysis

The IBM Centre of Excellence for Water Management case relates to two types of business agility need, the need for new product agility and the need for business transformation agility (i.e. develop new business models based on an open innovation model). The question is how new ideas and innovation opportunities can be picked up by a business, how quickly can these be translated into business propositions and business models (prior to competitors) and how quickly can organizational processes and IT systems be adapted to support these new business models. In this case study, we analyze the use of jamming technology to come up with new ideas for products and services and to open up a new market (water management). This case illustrates some of the challenges to identify new customer opportunities in the area of water management and to match these opportunities with internal expertise in order to develop new business propositions. Table 6.5 provides an analysis of the case study based on the case evaluation framework.

Table 6.5 – Analysis case 3 IBM Centre of Excellence for Water Management

Variable	Sub-dimension	Case 3
Event	Event Type	Spot opportunity for water management (via Jamming) and turn it into a new business model
	Event uncertainty	Response uncertainty (what type of business opportunity to pursue) and effect uncertainty (impact of the new business model on the IBM organization)
Business agility Need		Business transformation agility and new product agility
Business agility Sensing	What is sensed?	a) New ideas for innovation/business b) New disruptive technologies c) Customer opportunities for water management
	How is it sensed?	a) via Jamming session, technology adoption program b) internal information dissemination, relationships with labs, websites c) via meetings, conferences, virtual collaboration research lab
	Critical success factors	Using collective intelligence. Trust in information sharing. Sense-making (to filter for successful opportunities). Bridging social capital (both within IBM and towards external customers and partners) to scan for new opportunities
	Enablers and inhibitors	Enablers: IT tools (Jamming, text mining) Inhibitors: sensing overload (missing opportunities due to personal and organizational biases), over structuring and spreadsheet management on customer opportunities
	Maturity	High
Business agility Responding	How is responded to the event?	Turn Jamming outcome into a new business model. Match customer opportunities with IBM's and partners' expertise and turn these into projects related to water management.
	Critical success factors	Bridging social capital (both within IBM and towards external customers and partners) to match available expertise and tools to customer opportunities. Structuring the innovation process. Trust in information sharing.
	Enablers and inhibitors	Enablers: bridging role and tacit knowledge of water management staff

Variable	Sub-dimension	Case 3
		Inhibitors: existing mindset/mental models
	Maturity	Medium
Business agility Learning	How is learned from the event?	Based on evaluations of (previous) Jamming sessions sensing overload is reduced based on text mining tools. Local IT tools (Virtual Collaboration Research Lab) are used to experiment with and learn on new mechanisms for collaboration in the open innovation setting. On project level knowledge generated is stored for future re-use. Formal project evaluations are used to increase quality of future projects.
	Critical success factor	Trust among partners. Learning and information sharing among partners.
	Enablers and inhibitors	Enablers: text mining tools, tools for information sharing (such as virtual collaboration research lab) Inhibitors: missing opportunities due to personal and organizational biases
	Maturity	High
Sensing IT capabilities	IT capabilities	Corporate IT (CRM/Siebel, Jamming tools, Text Mining)
	Maturity	High
Responding IT capabilities	IT capabilities	Corporate IT (CRM/Siebel, group decision support software) and local IT (virtual collaboration research lab)
	Maturity	High (customer and partnering response implementation score relatively low)
Learning IT capabilities	IT capabilities	Corporate IT (CRM/Siebel, Knowledge DEAL database) and local IT (virtual collaboration research lab)
	Maturity	High
IT strategy	Enterprise architecture	Standardized processes and structured IT for Jamming and customer management (CRM). More experimental and less structured IT support for water management business development. Overall maturity: standardized technology.
	Knowledge management	<u>Support for Jamming:</u> Focused on Codification to capture and store ideas and discussion. <u>Support for Water management business development:</u> Focused on Personalization (to support bridging social capital). <u>Support for project execution:</u> Focused on Codification of knowledge in RETAIN.
	IT-business alignment	Medium
Business Agility Performance	Timeliness	High (IBM is one of the first IT companies to enter the market of water management; Jamming helps to shorten idea generation and evaluation process)
	Ease (cost)	Low (the use of Jamming is not cheap. It requires a lot of preparation and many people need to be involved in order to make it a success).
	Range (variety)	High (Jamming can be used to tap collective intelligence for different means). The types of services which can be offered related to water management are wide in range.

Variable	Sub-dimension	Case 3
	Quality	High (combination of knowledge of Jamming participants with the knowledge of IBM experts and managers), also in project development internal expertise is combined with external partners' expertise

The IBM Centre of Excellence for Water Management uses a model of open innovation and exploitation of the wisdom of crowds. Using collective intelligence can help mitigate effects of all kinds of personal and organizational biases in the generation of ideas and the evaluation of solutions (Bonabeau, 2009). Research of Surowiecki (2004) showed that groups or markets often make far better judgments than individuals. How can businesses tap into external knowledge and how can they convert ideas into actionable business ideas and business models? Increasingly, this requires collaboration and co-opting of partners and customers from the design of innovation opportunities (idea generation) through the execution in terms of products and services. With the Innovation Jams in 2006 and 2008, IBM used crowd sourcing as an innovative entrepreneurial agility approach towards innovation in the generation and evaluation of new ideas. This open-source-like approach actively makes use of the wisdom of crowds. The jamming technology and text-mining tools were important IT enablers for conducting crowd sourcing on a large scale as was done with the Innovation Jams. The Innovation Jam brought a number of advantages. It quickly generated a lot of ideas and channeled discussion, reducing the lead-time for idea generation. Since it reflected the opinion of the majority, the outcomes were made stronger. The event-driven nature of the Innovation Jam was one of the key success factors, having a condensed brainstorming session in three days.

One of the challenges faced by IBM in the previous use of Jamming technology was the possibility of sensing overload. Innovation opportunities might be overlooked, due to the enormous amounts of ideas that came out of the brainstorm. People have bounded rationality and limited information processing capabilities. Ideas needed to be clustered and analyzed into actionable opportunities. In preliminary jamming sessions manual work was required to cluster all the ideas into a manageable number of topics. Therefore, IBM Research developed the e-Classifier text mining tool. With this tool, discussion forums can be scanned to identify emerging themes and help participants to quickly grasp the essence of the underlying discussions in any forum (activity 2). This directly supports the sense-making capability. The e-Classifier text mining tool analyzes and clusters ideas around repeating words into categories. The idea being that repetition of words is a surrogate for energy or enthusiasm among the participants of the Innovation Jam. Another tool that supports sense-making in the Jamming process is IBM SurfAid. This tool provides real-time metrics on usage and demographic participation. Forum participation and discussion was influenced though real-time human intervention using both e-Classifier and SurfAid data (Østergaard, 2008). Although the text mining software helped to cluster and analyze the contributions, human involvement was still needed to review the clusters and correct any errors (Bjelland and Wood, 2008).

Using innovative IT such as the Jamming technology and the TAP programme (in)directly contribute to IBM's business performance, by shortening the time to generate and evaluate new ideas and bringing these to the market. A challenge for companies like IBM is that there is not a shortage of ideas. Unfortunately, a lot of ideas do not get the attention or resources that are needed, because there are simply too many ideas and people do not know how to handle that (i.e. sensing overload). Innovative IT can support sensing for innovation opportunities by supporting human processing capacities and reducing mental biases via tapping into the wisdom of the crowd. This improves empowerment of people within IBM.

"Empowerment on the level of individual employees is relatively low. If an individual employee has an innovative idea it is difficult to seize an opportunity – due to the organization's size of IBM. This needs to go via managers through the official channels and procedures. Innovative IT like TAP and Jamming has changed this, since anyone can bring their ideas to the attention of higher management with these technologies." ***Quote #3-11, Consulting partner, IBM Benelux***

Although the Innovation Jam is an important tool and enabler for open innovation and entrepreneurial agility in the idea generation phase, evaluations of the Innovation Jam show that such a large online conversation and brainstorm also brings a lot of complexity and challenges (Bjelland and Wood, 2008). Analysts and managers are essential in the sense-making phase – combined with sophisticated text mining software – to make the ideas useful. The implementation of applications that tap into collective intelligence, such as Jamming, need to take all kinds of issues into account (Bonabeau, 2009). These include striking the right balance between diversity (of participants) and expertise, providing incentives to keep people motivated and engaged, setting arrangements for ownership on resulting intellectual property and design of the basic mechanisms behind the applications, such as the choice for decentralized or distributed decision-making. Based on their experience with previous Jamming sessions, IBM carefully considered these issues during the setup of the Innovation Jam. The real power of the Innovation Jam was not the technology itself, but the conditions which were organized around it and the up-front commitment to the process and the results. Beforehand, IBM stated that it would not claim exclusive ownership on the ideas that were generated during the Jam and even more importantly, that it would invest 100 million dollars in the most promising ideas coming out of the Innovation Jam. This way a long negotiating process for setting up follow-up initiatives and finding finance was solved.

The case also described the next steps to turn the ideas of the Innovation Jam into concrete business opportunities in the area of water management. This is an even more challenging part of innovation. '*The real challenge comes with advancing, refining and building support for the ideas'* (Bjelland and Wood, 2008). This process builds to large extent upon the social capital of the people in the IBM Centre of Excellence for Water Management. This relates to the position and bridging role they fulfill within the organization and the connections they have with people inside and outside IBM (see Quote 3-2). Individuals who provide a '*bridge*' across divided communities (structural holes) are important, since they play a brokerage role (Newell *et al*., 2004). People need sufficient trust to share ideas and engage in joint innovation and use supporting IT (Quote 3-6). Social capital creates the relational layer between business processes and IT, required for connecting people, interfacing different IT and building trust. Trust is required for knowledge sharing – especially in open innovation. IT needs certain levels of social embeddedness (adoption, trust) in order to contribute to business agility.

6.4.5 Case 4: IBM Business Continuity & Resiliency Services

Introduction

In today's interconnected world, virtually every aspect of a business operation is vulnerable to disruptions. Some risks could take a business offline for days, but in a competitive environment, even four hours of downtime can prove fatal. Disruptive events range from data driven disruptions (e.g. viruses, disk failures), through business driven disruptions (e.g. disruptions due to marketing campaigns, compliance) to event driven disruptions (e.g. natural disasters, fires, mergers and acquisitions) with increasing consequences for the organization, and decreasing frequency of occurrences per year. IBM Business Continuity & Resiliency Services Benelux (IBM BCRS) helps businesses to avoid, prepare and recover from a disruption. BCRS has been in operation for about 20 years, employs about 100 employees and serves about 700 customers. All BCRS organizations worldwide are organized locally, since there are local differences with regards to the type of customers, the use of external partners and local requirements (e.g. due to changes in legislation).

The services from IBM BCRS range from planning and design through implementation and management. The strategy of IBM BCRS Benelux is to increase the depth and breadth of services in order to increase market share. The services offered are for external customers (about 75%) and also for IBM internal units and internal customers, such as outsourced contracts (about 25%). The services help ensure resiliency across all layers of the business, including strategy and vision, organization and human resources, business processes, applications and data, technologies and facilities. The service portfolio of IBM BCRS Benelux includes four services. *Disaster recovery services* are provided for recovering the business, infrastructure and employees in the event of a disruption. This includes the availability of an emergency diversion centre at the IBM premises, which can facilitate up to 400 people. IBM BCRS can also deliver IT equipment to the customer's premises using six trailers. IBM BCRS has a significant pool of equipment, including more than 1000 servers. *Information protection services* are geared towards protecting and recovering vital business information. IBM BCRS can mirror a customer's IT system and data real-time or can facilitate data backups via magnetic tapes. IBM also provides fault-tolerant, failure-resistant infrastructures with near-zero recovery times. Finally, *resiliency consulting services* are offered to assess, design and plan for resilient business infrastructure. These consultancy services are pro-active and help customers to increase the awareness of possible risks and to reduce the risks related to disruptive events. Research of IBM BCRS has shown that many customers are unaware of the potential risks they are exposed to in relation to disruptive events.

Business agility need

On a yearly basis, IBM BCRS Benelux needs to respond to between forty and sixty emergencies, which differ in type and impact. Dealing with an emergency requires high levels of adaptive agility. Customers' systems need to be brought back into operation as soon as possible. Customers can either make use of a mobile emergency diversion centre of IBM BCRS or use the emergency diversion centre at the IBM premises. This facility is reserved for major disruptions for which business operations are no longer possible at the customer's premises.

In 2008, an Apache helicopter hit an electricity line. Power services were completely disrupted in the region and (mobile) phone traffic was also no longer possible. Additionally, the IT systems of the customer were no longer working. The customer decided to move its people to the diversion centre of IBM BCRS, where people could continue their work, using the equipment and telephony of IBM, with their own data and applications. The customer had a contract with IBM to store configurations and data remotely. Therefore, facilities could quickly be arranged for the customer to work with their own data in the IBM provided environment. After the incident was reported, facilities were arranged and set up. The moment the customer's employees arrived to the IBM building, they could start working.

Sensing, responding and learning

Here we describe how IBM BCRS in normal cases responds to an emergency for onsite diversion. Figure 6.9 provides an overview of the core sensing, responding and learning activities and the supporting Information Systems and Tools of the BCRS organization for the onsite diversion centre service**.** Based on the empirical research, thirteen activities were identified. Four activities (3, 6, 7 and 11) are (partly) sourced from external partners. The BCRS database is the core IS and supports the main BCRS activities.

There is a central emergency number (IBM 3939) customers have to call in the event of an emergency (activity 1a). The helpdesk reached by this number is managed by IBM MTS. The phone call is then dispatched to the specific crisis coordinator on duty, depending on the type of platform the emergency relates to. If the call is not answered within ten minutes the call is automatically rerouted to a second or even third person (coordinator which is on duty). Personal relationships and trust are important in the relationship with customers, as the following quote illustrates.

"The personal contact, the type of activities and the service orientation of our staff positively influence the agility and speed of our response. What you often will see is that before the customer calls the official calamity number, he first calls the coordinator to inform him about the calamity. The coordinator has built a position of trust with the customer and he can already think along with the customer about possible solutions. Via this informal communication the coordinator already can initiate the process within BCRS, while the formal process starts after the official calamity number has been called." ***Quote #4-1, Technical Solutions Manager IBM BCRS***

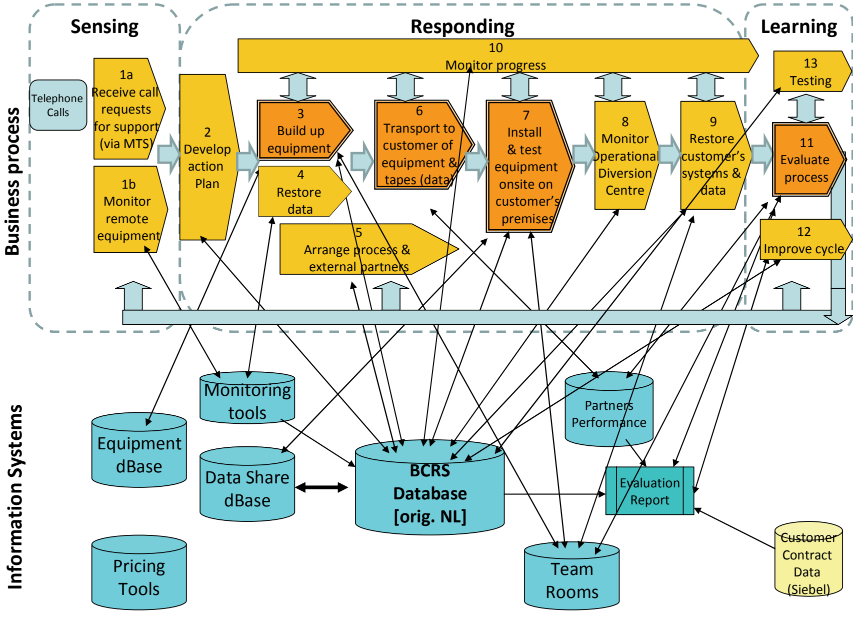

Figure 6.9 - Service delivery process and core Information Systems and Tools IBM BCRS

The phone call is verified and the customer is called back to discuss the crisis. This is one of the critical points in the sense-making process, since after this contact a plan needs to be made to solve the crisis (activity 2).

"The most important information source in the event of an emergency is the customer itself. The customer has the most recent information, which might be missing in the databases. People that contact the customer about the calamity need to get as much as possible information from the customer to respond with a solution that works." ***Quote #4-2, manager IBM BCRS Benelux***

Depending on the type and size of the emergency, a plan of approach is tailored to the wishes and local situation of the customer. This includes a choice for the solution (usage IBM emergency diversion centre or building up an emergency centre at the customer's premises with mobile equipment), where to build up the infrastructure *et cetera*. Each emergency is different and for each emergency tailor-made solutions are required. However, every emergency is handled in a predefined logical order. This order is based on standards and results of extensive testing, which has been done in collaboration with the customer (activity 13). The results of these tests are stored in the BCRS database.

IBM BCRS has contradictory requirements for personnel that work at BCRS. People who work at BCRS have two types of tasks, which pose different (and sometimes even conflicting) requirements for the skills and attitude of people (ambidexterity). On the one hand there is the need to act in a crisis situation, which requires imagination, improvisation skills and the capability to work under stressful situations. There is some structuring of the response process; however imagination and creativity based on tacit knowledge are the key to a successful response.

"Critical aspects to enable a speedy and agile response are communication, expectation patterns and using a scenario with a logical chronological order of activities. This is complemented with the knowledge which resides in heads. With this knowledge you are able to make combinations and connections and generate new ideas, with databases this is not possible." ***Quote #4-4, Technical Solutions Manager IBM BCRS***

On the other hand, hundreds of repeating and structured tests (simulated calamities) need to be done each year. This is a highly disciplined process, to train staff in dealing with emergencies in a controlled environment. These tests need to be done on a very structured basis, with all kinds of security requirements. People going out on emergency calls need to have the knowledge of the equipment, the response process, the necessary process steps and their team members . Finding people that fulfill both skill requirements is not easy.

In the event of large emergencies, a crisis team is set up, and a crisis manager is assigned to manage the process. The manager is empowered to make the necessary decisions to come up with a solution for the client.

"In case of a real (technical) escalation with a client, a crisis manager is appointed to come up with a solution. If something happens in a specific part of the organization, often other things are going on. In such cases, the crisis manager is empowered by the business line executive, to get support from all parts of the IBM organization – even globally- to come up with a solution (i.e. response), without resistance from the existing hierarchical lines of the formal organization. Although IBM is a global organization with many processes, in these cases there is a bypass in order to respond quickly." ***Quote #4-5, former Technical Solutions Manager IBM BCRS***

In most cases responding to a calamity is a continuous 24*7 process, so after each shift of eight to ten hours, another coordinator manager and another team takes over. Therefore all actions and progress is logged in the BCRS database. Everyone can approach and update this database from multiple channels, including mobile access. Each BCRS employee has a replica of this database on his/her laptop and via an internet connection data can be replicated. Depending on the size of the customer, it can take up to two days to rebuild the (mobile) computing centre.

The crisis manager remains in contact with the customer, manages the overall process and also involves external parties on an as-needed basis, like transport, batches *et cetera* (activity 5). Communication with external parties is mainly via phone, since this is always tailor-made. The crisis coordinator is responsible for building up the equipment (activity 3). The crisis coordinator works from a specific base configuration and adapts that based on the specific customer configuration or situation. In the event of ambiguity or further questions, 2nd line support can be called. IBM BCRS arranges all the equipment (in this specific case 60 servers) and brings these with trailers to the customer's location. All equipment is stored in modular mobile 19 inch reconfigurable racks (flight cases). This way, a complete computing centre can be built modularly. Virtualization tools are used to make optimal usage of the available server capacity. Redundancy has been built into the available systems and mainframe (extra hardware capacity), in order to serve the five biggest customers simultaneously in case of multiple or widespread emergencies; on the personnel side, extra personnel can be hired from other IBM divisions. The configurations and equipment in the other Benelux BCRS divisions are the same as those in the Netherlands. If there is a need for extra capacity, capacity can be shared and exchanged. In this way an extra level of resilience has been built into the BCRS operations itself.

Customer's systems and data are loaded on the equipment. Customers are always responsible for their own data. Customer data can be available within IBM BCRS or at the customer's premises (activity 4). There can be a (semi) real-time mirror of the customer's data, available 24x7 at IBM BCRS or data can be available based on the tape transport service, which picks up a magnetic tape once a day containing all of the customer's data from the previous working day. All these magnetic tapes are stored at IBM BCRS. In the case of an emergency, the tapes can be used to copy the data onto the servers with tape robots, while the diversion equipment is still located at IBM. Alternatively, the tapes can be transported to the customer's premises.

The core of emergency response is done by IBM BCRS themselves. This includes all critical activities (people and equipment) and relates to about 95% of the costs involved. Besides using its internal capabilities, IBM BCRS works with over 50 external partners, which are part of the value chain of IBM BCRS (activity 5). Examples of partners are lease companies (busses for tape transport), software companies, tape chauffeurs (via a temporary employment partner), database maintenance, delivery of diesel generators, lorries, maintenance and technology support (IBM MTS and others). IBM BCRS also has facilities and arrangements with KPN and other telecommunication operators for diversion of telephony. This makes it possible to transfer the customer's employee phone numbers (temporary) to the diversion centre. For the customer this means that business operations can continue and people can still be reached, as if they were still working from their normal office location. Most partnerships are fixed by long term contracts. Trust and short communication lines between people are important. The products of the external partners are an important part of the value chain of IBM BCRS. For the diversion services the contribution of these external partners is highly important. As such, these partners are treated differently and monitored more closely by the technical delivery manager. For some fixed partners like tape transport, chauffeurs and equipment maintenance performance is measured and monitored based on SLAs. Detailed agreements are in place regarding what they are (not) allowed to do and how often they need to report back. However, in most cases it is not possible to track performance of partners with some kind of tooling, since activities are so ad hoc and unpredictable.

"Having a value chain and working with partners works on the basis of the weakest link principle. If one link falls out, the service cannot be delivered" ***Quote #4-9, manager IBM BCRS Benelux***

There is not a formal monitoring function in the whole process. However, at regular points in time so called checkpoints are created, where all parties involved, including management, come together (physically and/or via a conference call) to discuss the situation and progress (activity 10) .The specialist in the field is empowered to decide on an approach and work to the best of his knowledge in close collaboration with the management of the customer. This is reported back to IBM management, who discuss and evaluate the proposed approach and approve it or modify it. This again is stored in the BCRS database.

The complete (mobile) computer centre is brought to the customer's premises, where it is put into operation (activity 7). Based on contracts with the customer this is done within four hours or in steps of four hours. After the emergency has passed, there is always a point in time, after which the temporary diversion centre will be dismantled and operations will be restored on the customer's premises on new equipment (activity 9). Customers are responsible for this process with the help from BCRS. This is a planned process, which usually takes place during a weekend. Also during this process data from the BCRS database is used to rebuild the infrastructure. Data is transferred back onto the customer's equipment. After each emergency an evaluation report is made for the customer and IBM BCRS (activity 11). This report is based on the data logged in the BCRS database. This evaluation report feeds lessons to learn and is used as input to improve the future process (activity 12).

"The people work here for a very long time. During the years this has grown into a friendly basis, where everyone has become friends with one another. In case of a calamity, everyone is willing to help each other and work along. The informal aspect is big strength of the organization." ***Quote #4-6, Technical Solutions Manager IBM BCRS***

The activities, part of the onsite emergency diversion in the event of an emergency are mainly reactive, however, the regular training for such emergencies can lead to proactive feedback for the customer to improve certain processes, making the diversion of an emergency more smooth and agile. The continuous training for emergencies also includes a continuous feedback loop to further improve the delivery process or required resources of IBM BCRS (activity 13). After a test or training scenario has been administered for a customer, IBM delivers a test report with recommendations, for instance to increase recovery point objective (RPO) and recovery time objective (RTO)[19]. In the past, IBM BCRS has learned a lot from small mistakes and accidents.

Feedback is important for BCRS to improve its services. All types of feedback are appreciated and used. The customer fills out an evaluation & feedback form after each event (tests and calamities). These customer evaluations are grouped and reported back and discussed in quarterly team meetings within BCRS. BCRS employees can bring in their own ideas or suggestions to improve services. Recently, the Customer Advisory Board (CAB) with 5 to 7 major customers has been set up. CAB regularly (every 2 months) provides feedback to IBM BCRS services. In a joint dialogue IBM and CAB try to further develop and improve operations (activity 11 & 12).

IT capabilities support for sensing, responding and learning

There is a wide range of database tools and information systems, which are used by IBM BCRS. These databases are used to store customer information, equipment information, pricing information, customer equipment configurations, testing results and possible

[19] For a more extensive glossary of Business Continuity & Technology terms we refer to http://recoveryspecialties.com/glossary.html

solutions to deal with specific disruptions. IT provides the lubricant for the BCRS process. BCRS uses agent software to monitor customer's IT systems and data as part of the data mirror service. These agents can pro-actively sense possible disruptions and generate alerts in the event of disruptions or significant changes in threshold values. For instance in the event that databases are reaching capacity or communication lines are not working properly (activity 1b) then alerts can be sent to the appropriate respondents. Another IT tool monitors the location of cars on the basis of GSM communication and GPS. In case of an emergency, BCRS can respond in a very short time and quickly bring backup tapes to the customer location, since it is known exactly where people and cars are located.

The most important database is the BCRS database, which contains ten years of IBM BCRS work history. The database contains all the contracts, address data of customers, customer configurations (which reflect the results of the latest test), drawings, test reports, event logging and -reports.

"The customer configurations which are stored in the BCRS database provide the blueprint for the design of the diversion centre equipment architecture. You always take the equipment, which also worked during the last test, as the basis for your solution. This provides the highest level of trust that it will also work for the calamity." ***Quote #4-10, Technical Solutions Manager IBM BCRS***

IBM BCRS uses the central Siebel systems, but also uses its own BCRS database to store data on customers. This leads to a certain level of redundancy. The BCRS database was built specifically for IBM Netherlands by an external partner. The worldwide IBM system, CMT, did not fit with the processes of IBM BCRS Benelux. One of the key differences is the tape delivery process, which is managed by IBM BCRS itself, while in other countries this process is fully outsourced. The BCRS database was built in Lotus. New fields can be easily added to the database and users can make (their own) queries to access specific data. There is also a database with capital expenses on all equipment of BCRS. Another tool where data is stored and shared is a directory called *data-share*, which is connected to the BCRS database. Here all kinds of software (components) and files are stored. Besides internal tools, Google is also used to search for information and solutions on specific problems. In addition to logging data in the BCRS database there is always parallel e-mail communication related to handling the emergency. IBM BCRS has also gone through a phase of codifying the tacit knowledge of its employees.

"Knowledge is gained and transferred from one person to another and via regular testing. Since employee turnover is very low (less than 1%), there is no panic in relation with time that needs to be spend on new people, who quickly have to learn the work routines within IBM BCRS. Years ago, a lot of knowledge was tacit knowledge, only available in the heads of people. Then it was decided to start working more structured and process-based and to document and codify this knowledge as much as possible in databases to be able to share it. This also helps for new employees to get settled

*in their job and gather knowledge from experienced colleagues. Most of our knowledge now is stored in the BCRS database." **Quote #4-11, Technical Solutions Manager IBM BCRS***

Although a lot of data is stored in the BCRS database, a lot of tacit knowledge on the process logic to handle an emergency still resides in the heads of people.

*"The databases are used in problem resolution, especially for storage of facts. However, still a lot of knowledge resides in the heads of people. IT moves very fast, what you buy today is obsolete tomorrow. Also the knowledge associated with this IT. Since people do hundreds of tests each year, most of the process- related knowledge [if this…then ….] becomes routine tacit knowledge inside the heads of people. The logic required for conducting a test is more or less the same than for an actual calamity – in both cases the goal is to bring applications up and running again. ...Being flexible and solving something for a customer is not something that can be stored in a database. It is the mental attitude and flexibility of people which is important, and their practical experience in solving a calamity quickly." **Quote #4-12, manager IBM BCRS Benelux***

Besides the BCRS database there are different team-rooms (databases), which are organized per subject, technology or process. These databases contain a lot of (semi-) structured information such as notes, documents *et cetera* which can be browsed. Most databases are made by employees of IBM BCRS, since technical engineers working at IBM BCRS are skilful in the development of databases. All these different databases bring new challenges of information overload and a lack of data transparency.

*"Information is stored in many different databases. In practice it can be difficult to find the right information. All systems have grown in the past to what they are right now. We are accustomed to have so many databases within IBM. But I think every organization has these kinds of problems." **Quote #4-13, manager IBM BCRS Benelux.***

Social capital, especially personal relationships are important as a means to circumvent these (IT) islands of knowledge.

*"We notice that IBM is organized as islands of knowledge. There are attempts to stick these islands to each other. However, as long as data is stored locally in the own language, connecting the different databases will bring not much value. We do not need databases to make international contacts to the BCRS line of business in other countries. These contacts exist based on personal relationships and the network which can be mobilized to find and contact people." **Quote #4-14, Technical Solutions Manager IBM BCRS***

Business agility performance

According to the manager of IBM BCRS, BCRS is one of the most successful units within IBM. The manager believes that the strong team spirit is one of the key contributions to the high performance levels of his unit. A strong customer orientation and satisfied employees have led to increasing levels of business agility performance with positive effects on business performance.

Based on the empirical evidence, we analyzed business agility performance of BCRS to respond to an emergency from the perspective of four change proficiency metrics (Dove 1995, 2001). *Response time* scores high (relatively short response times). The bonding and bridging social capital of BCRS, supported by the use of IT helps to quickly respond to an emergency by connecting the different departments and people involved. *Response ease* (costs) scores medium on average. The relative ease of response depends on the emergency in question. *Response quality* scores high. Extensive testing of emergency support predictability and timeliness of the response yields a high response quality score. *Response range* scores high. BCRS supports both pro-active and reactive response measures for different types of risks (data, business and event driven risks). Response can be delivered remotely, on the clients premises or in-house (diversion centre).

Analysis

Business continuity and resiliency services are people-oriented businesses. IBM BCRS successfully delivers resiliency services to customers for highly uncertain disruptive events, which can be data driven, business driven or event driven. IBM BCRS is organized as a high reliability crisis organization and uses partnering agility for a few selected capabilities, like the temporary transfer of phone lines. On the customer agility dimension IBM BCRS involves its customers in extensive testing and training for possible emergencies with a continuous feedback and learning process. Customers are pro-actively helped via consultancy services to identify possible risks and take measures to reduce these risks. IT capabilities provide some support in the sensing process, specifically for monitoring remote equipment and sensing disruptions in the backup of data. One of the critical capabilities is the sense-making capability to diagnose the type of emergency and connect it to a suitable response design and action plan. Sense-making is mainly based on the heuristic knowledge (tacit knowledge and improvisation skills) of BCRS people. Once the exact type and scope of event has been identified, the next steps in the response process are based, to a large extent, on the explicit knowledge, which is stored in the BCRS database. Learning takes place via extensive testing and training for emergencies and on the basis of evaluations with customers of BCRS' response to a disruption. The results of this learning process directly feed the future response process via updates in the organizational memory IT (BCRS database). The response time is one of the key business agility performance metrics, since business continuity depends highly on the time it takes to respond to and solve the emergency. The business agility performance level of the BCRS unit depends to a large degree on the internal bonding and social capital. Table 6.6 provides an analysis of the case study based on the case evaluation framework.

Table 6.6 – Analysis case 4 IBM BCRS

Variable	Sub-dimension	Case 4
Event	Event Type	Crisis / calamity at customer's premises
	Event uncertainty	Time/location uncertainty of the calamity and effect uncertainty (impact on client's organization)
Business agility Need		Business Efficiency Agility / Improvisational Agility
Business agility Sensing	What is sensed?	Calamity at customer via calls from customers (phone) Status of remote equipment
	How is it sensed?	Via helpdesk Remote monitoring of equipment via agent software
	What are critical success factors?	- The (heuristic) knowledge of the 1st line crisis coordinator and the ability to quickly make sense of the type and scope of the event - Personal relationships and trust
	What are enablers?	Electronic agent software
	Maturity	High
Business agility Responding	How is responded to the event?	Develop an action plan and implement a response (solution) based on previous testing and heuristic knowledge from employees, deliver solution in collaboration with over 50 external partners.
	What are critical success factors?	- The (heuristic) knowledge of the 1st line crisis coordinator. - Logical order of response process (based on tests, stored in BCRS database) - Bonding social capital among BCRS employees. - Ambidexterity of people skills (improvisation and stress response on the one hand, discipline and structure on the other hand)
	What are enablers and inhibitors?	Enablers: - People skills and bonding social capital - Empowerment of crisis manager. - Modularization of equipment - Redundancy of configurations and equipment - Transparency on process and progress in BCRS database - Capability to quickly involve loosely coupled network of external partners
	Maturity	Medium
Business agility Learning	How is learned from the event?	Based on continuous testing and evaluation of handling a specific calamity the sense-respond process cycle is improved and results are stored in the BCRS dBase. Trailer calls are used for evaluation and improvement.
	What is a critical success factor?	Continuous testing with feedback loop and storage of results in BCRS database
	What are enablers and inhibitors?	Enablers: continuous testing, BCRS database and customer feedback Inhibitor: lack of information sharing with other (BCRS)

Variable	Sub-dimension	Case 4
		units, lack of shared database/language with other units
	Maturity	High
Sensing IT capabilities	IT capabilities	eServices (agent software and eServices)
	Maturity	Medium
Responding IT capabilities	IT capabilities	BCRS database Customer data storage mirror IT service.
	Maturity	Medium (relatively little IT support for partnering response)
Learning IT capabilities	IT capabilities	Local IT (BCRS database, Data share dBase, Partners Performance dBase) and Corporate IT (Team Rooms)
	Maturity	Medium (relatively little IT support for customer and partnering learning & feedback)
IT strategy	Enterprise architecture	Local IT platform, redundancy with corporate IT. Lack of data sharing and standardization. Overall maturity: business silos
	Knowledge management	Focused on Personalization with some codification
	IT-business alignment	Medium. Islands of knowledge, due to mix of corporate and local databases.
Business Agility Performance	Timeliness	High
	East (cost)	Medium
	Range (variety)	High (there is a wide range of solutions which are offered to respond to a variety of risks)
	Quality	High (due to extensive testing of calamities and highly experienced staff).

The BCRS unit cannot be compared to normal firms that need to be agile to respond to uncertain events. The BCRS unit is specifically designed for adaptive agility to deal with highly uncertain disruptive events. BCRS is an example of a high reliability crisis response organization. Many authors (such as Quarantelli, 1988; Roberts, 1990) have studied such organizations and their characteristics. We will compare the similarities and differences of high reliability or crisis response organizations with the BCRS case.

One of the key capabilities of crisis response organizations is the sense-making diagnostic capability to analyze the type and urgency of the crisis event and develop a proper action plan to respond. Instead of detailed disaster plans, creativity and imagination under crisis circumstances are more useful (Quarantelli, 1988). The response capability of high reliability crisis response organizations depends to a large extent on extensive training, incorporation of redundancy, a loosely coupled structure and empowerment of lower level employees in decision making (Roberts, 1990). Empowerment and autonomy in decision-making are the key to making a workforce truly agile (Goldman *et al*., 1995; Kidd, 1994). There needs to be a certain level of shared (organizational) memory, to build upon (previous) expertise. Crucial data needs to be recorded during a crisis response. Poor, incomplete or inefficient communication flows are one of the key challenges in dealing with crisis situations (Quarantelli, 1988). Finally, crisis response organizations use (information) strategies to reduce the possibility of a crisis.

BCRS has applied the characteristics of a successful high reliability crisis response organization in its processes and IT. The BCRS database is used as the shared (organizational) memory of IBM BCRS. This database is used to store knowledge on previous events, results of tests and customer configurations. Crucial data in the pre-crisis stage (configurations of customer equipment, details of tests) and during the crisis situation (action plans, activities and progress) are recorded in the BCRS database. IT is also used to create visibility on the location of resources in the event of a calamity.

One of the key capabilities of crisis response organizations is the sensing capability. Specifically the ability to sense a (possible) crisis event and invoke a diagnostic capability to analyze the type and urgency of the crisis event is important for developing a proper action plan (response design). IT is used to increase the sensing capability and improve pro-active response mechanisms. For instance in the customer data mirror service, IT generates alerts in the event of (possible) disruptions. With regards to sense-making diagnostic capabilities and response design, IBM BCRS has trained its people to use their creativity and improvisation to come up with solutions under stressful situations, rather than use strict and structured action plans. Orlikowski (1996) refers to this as *heuristic knowledge*. However, some overall structuring has been made to maintain consistency in the approach. People are selected based on these capabilities. The response capability of high reliability or crisis response organizations depends to a large extent on extensive training, incorporation of redundancy and empowerment of lower level employees (Roberts, 1990). These concepts are also applied in the BCRS organization. BCRS makes use of extensive training for emergencies. Certain levels of redundancy are built into the available equipment of BCRS, data (storage), communication facilities, work locations, the capabilities of people and the BCRS software, which has multiple versions and redundant databases installed on the laptops of employees.

IBM BCRS acts like a network orchestrator, with a network of partners to respond to a crisis situation. IBM BCRS avoids tight coupling via long term contracts and information system integration, but rather organizes itself as a loosely coupled network. A wide network of connections and partners are available, depending on the need and crisis event, some of these connections can be put into operation. For some partners ties are stronger, like the use of tape delivery transport operators and telecom companies for the telephone diversion services. These tasks require trust and intense cooperation, so strong ties are preferred (Uzzi, 1997). Higher levels of maturity in performance measurement and evaluation are applied to these partners.

Social capital is a relevant factor for high reliability crisis response organizations. The level of business agility performance of the BCRS unit depends to a large degree on the heuristic knowledge (tacit knowledge and improvisation skills) of the employees. This knowledge can only come from learning on extensive testing on emergency scenarios and evaluations of real emergencies. This learning is buttressed by the existence of internal bonding and social capital. The culture of BCRS can be characterized as friendly with high levels of trust, knowledge sharing and informal ties within the organization (see Quote 4-6). Trust is an important binding element among people but also in customer relationships (see Quote 4-1). The social capital of the BCRS unit provides the basis and the lubricant for the whole BCRS business process. The attitude and tacit knowledge of the people working for IBM BCRS distinguishes the unit and makes it highly agile to respond to highly uncertain crisis situations (see Quotes 4-3, 4-11, 4-12). The presence of an informal structure permits the organization to react quickly to internal and external shocks and to continue to excel, while more formal strategies and structures need time to catch up and remain updated (Chan, 2002).

6.5 Lessons learned

Based on our research we did a cross-case analysis to analyze the three research questions. Each research question is analyzed and discussed below. Each research question results in a proposition on the relationship between the two constructs (relationship between IT capabilities and business agility, relationship between event uncertainty and business agility, and relationship between business agility and business agility performance). For some of these relationships propositions are put forward on the conditions that influence the relationship.

Research Question 1: How do IT capabilities impact business agility?

The importance of IT capabilities and the relationship with business agility (performance) differs significantly among the four cases. Case 1 (resource deployment) is characterized by a strong usage of IT, because the deployment of resources is so predictable (relative to the other cases). In contrast, Case 4 (BCRS) illustrates a smaller role for the IT capabilities. The key in the BCRS case is that the normal business process is bypassed and the person who is assigned to lead the response on behalf of IBM BCRS is empowered to do whatever the situation requires. In Case 3 the Jamming session was supported to a large extent by IT, while the business development part of the IBM Centre of Excellence for Water Management is more unstructured and experimental with less IT support. These differences are also reflected in the scores of the different constructs for the four case studies, based on an analysis with the agility research instrument (Figure 6.10). The analysis of the results for Case 1, 2 and 3 indicate a pattern, where higher levels of IT capabilities correspond with higher levels of business agility. In Case 1, IT capabilities and business agility have an almost similar score. This case relates to responding to events with relatively low levels of uncertainty and high levels of predictability. Therefore the SRL-cycle can be largely embedded into IT capabilities, which explains the similar scores. In Case 4 business agility scores relatively high, leading to a high business agility performance score. However, IT capabilities are relatively low compared to the other cases. Apparently, there are other factors that explain the high level of business agility performance in Case 4.

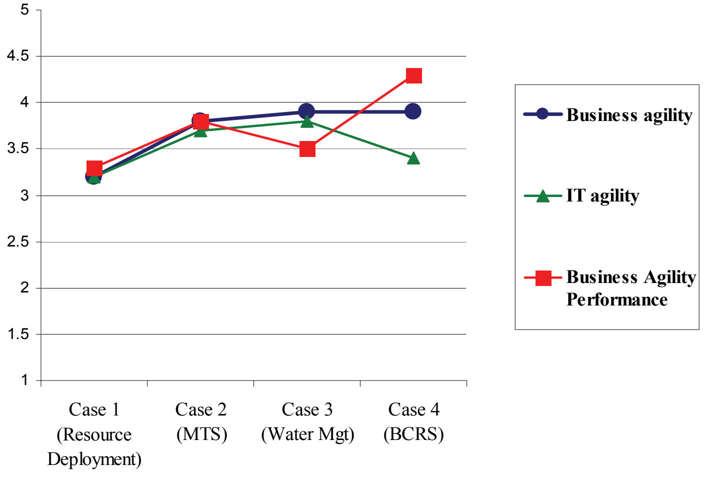

Figure 6.10 - Overall cross case analysis (based on agility measurement instrument)

Overall, the cases confirm that there is a high dependency of business agility on IT capabilities. Often, IT is a blended part of the business process, as is illustrated in Figure 6.5 Figure 6.7**,** Figure 6.8 and Figure 6.9**.** In Case 1 (Professional Marketplace), Case 2 (RCMS and Knowledge DEAL), Case 3 (Siebel) and Case 4 (BCRS database) there is one central information system that provides an important basis for sensing, responding and learning capabilities.

An important element in the design of the enterprise architecture relates to the links between the dynamic capabilities, which can be used as a measure for alignment. This relates to links (human or IT interfaces) among sensing, responding and learning (SRL business alignment), links among IT capabilities (SRL IT alignment) and links between business capabilities and IT capabilities (Business-IT alignment). Appendix C, Table 3 provides an analysis of the links, where a codification is used with value ‘low’ (no or very limited linkages), ‘medium‘(some linkages), or ‘high’ (highly linked), based on an analysis of the interview transcripts. Ideally, there should be mechanisms to link information that results 1) from sensing to responding and 2) from learning (organizational memory, information dissemination) back to sensing and responding. The analysis shows that IT capabilities are linked to a large degree to the business capabilities, especially to response capabilities (business-IT alignment). The analysis also shows that IBM is relatively weak in SRL alignment among IT capabilities. The lack of data quality and the existence of business silo's leads to a relative weak cross sensing, responding and learning process at the unit level and between the different units at the enterprise level. Data from sensing IT is insufficiently linked to response IT, and data that emerges from learning IT insufficiently feeds back to the sensing and response IT.

There are a number of examples providing evidence that alignment among sensing, responding and learning IT supports higher levels of business agility. The MTS case provides an example of how sensing data (agent software installed on customer's equipment) directly triggers the response process (initiation of call in RCMS system). In Case studies 1 and 3 Siebel and PMP provide sensing data, that directly triggers a response process (for instance the need to increase sales activities or the need to acquire new skill sets on the labor market). In Case 4 data resulting from learning capabilities (testing) is stored in the BCRS database; this data is used again to improve the response process for solving an emergency. The lack of links (IT interfaces) between different IT systems requires human interventions to ensure actions are taken and data from one system or process is used in another. This can be a time-consuming and inefficient process. For example, in Case 1 this is illustrated in the collaboration between the resource managers and external partners in resource deployment. Previously, this collaboration lacked IT interfaces between sensing IT (need for human resources in PMP) and response IT (available external resources in partners' IT). This generated a lot of extra work, errors and hindered business agility performance. This brings us to the following proposition:

Proposition 1: *Higher levels of IT agility support higher levels of business agility and lead to a better business agility performance under the condition that sensing, responding and learning capabilities are aligned among each other and IT capabilities are aligned with business capabilities*

The cross-case analysis provides evidence for the conditions under which IT supports higher levels of business agility.

Standardization

Previous research pointed to the standardization of IT capabilities to support higher levels of business agility (Ross *et al.*, 2006; Ross, 2008; Tallon, 2008). Ross referred to the agility paradox. Although it might sound contradictory, standardization of IT makes a firm more agile (Ross, 2008). Standardization is relevant to the different layers of the enterprise architecture, ranging from interfaces (i.e. network connectivity), through compatibility of hardware (Byrd and Turner, 2000; Tallon, 2008) to the standardization of data formats and even enterprise processes. Standardization is a necessary condition for quickly connecting to partners' capabilities - for sharing of data and to measure performance. An integral view on customers, events or resources can be missing due to the lack of standardization of data (Quote 2-14). The MTS case provides some examples on how the ability to integrate different data sources and interpret this richer dataset directly supports business agility (Quotes 2-12, 2-13, 2-14). The cases provide various examples regarding how a lack of standardization hampers business agility (Quotes 2-8, 2-9, 2-16, 4-14). This results in the following proposition:

Proposition 2*: Higher levels of standardization in IT capabilities support higher levels of business agility*

Increasing the level of standardization in corporate IS can reduce local flexibility (Ross *et al*., 2006; Ross, 2008).The following example illustrates how the lack of local adaptation and customization can lead to delays, local (informal) turnarounds and redundancy of data.

"The standardization and centralization of IT infrastructure and core IS has had both a positive and negative effect on business agility. Due to the high degree of centralization and standardization of corporate IS relative simple changes can be implemented quickly throughout the organization. This only requires reconfiguring certain parameters in the corporate IS. However, at the same time, this high degree of centralization also hampers business agility. Especially local adaptations or customizations are difficult and it is time consuming, to have this accepted and implemented at a central level. Depending on the exact requirement this can take weeks, months or even years. The central systems lack certain levels of flexibility. As an example, customization of invoices (details, layout etc) . It is difficult if not unfeasible to customize this for a specific client ...If everything operates as normal and expected there is no problem. If something becomes non-standard or goes wrong, it leads to delays.." ***Quote #5-1, Consulting partner, IBM Benelux***

Data quality

IBM has a long standing history of managing data in databases. The four cases discuss a variety of databases that are used to store customer-, process-, product- and resource data. Some of the databases were developed many years ago, with web interfaces connecting to these different databases. Together these databases make up the organizational memory of IBM and are a vital element in daily operations, enabling sensing, responding and learning. The cases point to a lack of data quality, since data is sometimes dispersed in many different corporate and local databases, insufficiently accessible to other departments due to inconsistent data formats and semantics or simply due to a lack of shared language (see Quotes 2-8, 2-9, 4-13, 4-14). IT can limit business agility due to a lack of data quality and data transparency (stove pipe systems, local differences) and inflexibility of corporate IS.

If local conditions and requirements do not match with global database structures, this leads to (redundant and possibly erroneous) local systems and databases. Besides an IT architecture perspective on data quality, people and their social structures influence data quality, such as trust, willingness to share data and discipline to maintain data accuracy and timeliness (Quotes 1-7, 1-8, 1-10). This results in the following proposition:

Proposition 3: *Higher levels of data quality support higher levels of business agility*

Enterprise architecture maturity

Linked to the issues of standardization and data quality is the maturity of the enterprise architecture. The enterprise architecture and especially the information architecture has a large effect on the degree to which IT capabilities support, enable or hinder business agility (Ross *et al.*, 2006; Ross, 2008). Different case study quotes illustrate the importance of the information architecture in relation to IT agility and business agility (see Quotes 2-9, 2-12, 2-13, 2-14, 4-13, 4-14).

Table 6.7 provides an overview of the enterprise architecture (maturity) components of IBM for the four case studies. The enterprise architecture of the four IBM units ranges between *business silos* and *optimized core* (Ross *et al*., 2006).

In Case 2 (MTS) and Case 4 (BCRS) there was some sharing of enterprise wide standards and IT. These units work based on local procedures and specific expertise. They use a hybrid model with a stable, standardized and centralized IT infrastructure and enterprise-wide corporate IS, with (local) tools to increase IT agility and data transparency. The use of local tools in addition to a centralized IT architecture provides an extra layer of agility making it possible to connect global data with local data and local business rules. However, this may only be a temporary solution in the quest towards higher levels of enterprise wide business agility.

In the next enterprise architecture stages (optimized core and business modularity (Ross *et al*., 2006)) such agility needs to be incorporated via plug-and-play business process modules and services.

These results bring us to the following proposition:

Proposition 4*: Higher levels of enterprise architecture maturity support higher levels of business agility*

Table 6.7 - Characterization of Enterprise Architecture for four IBM cases

Enterprise Architecture Component	Case 1 Resource Management	Case 2 Maintenance & Technology Support	Case 3 Jamming & Water Management	Case 4 Business Continuity & Resiliency
Processes	Standardized enterprise wide Some local differences	Standardized enterprise wide (GSDP process) Some local differences	Jamming: standardized Water management: less standardized	Some standardization, local differences
Enterprise wide systems	Siebel, PMP, Knowledge DEAL	SAP, Siebel, Knowledge DEAL	SAP, Siebel, PMP, Jamming, TAP, Knowledge DEAL	SAP, Siebel, Spare parts mgt, Knowledge DEAL
Local applications	-	RCMS, local databases and tools, information warehouse	-	BCRS dBase, local databases and tools
Data sharing	Global	Local / Partly global	Global Partly local	Local
IT infrastructure	Shared technical IT platform	Shared technical IT platform	Shared technical IT platform	Local IT platform, Some level of sharing with other BCRS units
Architecture Stage (Ross *et al*. 2006)	Optimize core	Standardized Technology/ Optimized Core	Standardized Technology/ Optimized Core	Business Silo

Social capital

The case studies indicated that social capital is an important variable influencing the relationship between IT capabilities and business agility. Newell *et al*. (2004) distinguish between two forms of social capital – external bridging social capital (relating mainly to the (informal) relationships among people) and internal bonding social capital (relating mainly to internal ties, shared purpose and internal cohesiveness). The importance of external bridging social capital – the social network and relationships which are essential for quickly linking to other people if there is a need for agility - is illustrated via different examples and quotes from the different case studies (Quotes 1-8, 2-4, 2-5, 2-6, 2-7, 3-2, 4-1, 4-2). External bridging social capital or (informal) connectedness (i.e. personal relationships and networks), is an important element in sensing, responding and learning. The results from the case studies also suggest an important role for internal bonding social capital (Quotes 2-7, 3-10, 4-6, 4-8). Newell *et al*. (2004) explain that "*for the effective mobilization of 'weak' social capital bridges for collective purposes, there is first a need to create 'strong' social capital bonds within the project team so that it becomes a cohesive social unit that will be able to effectively integrate knowledge that is acquired through the bridges*". These results were also found in previous studies. Jansen *et al*. (2006) found informal coordination mechanisms (i.e. connectedness) often contribute more to pursuing exploratory and exploitative innovations than formal coordination mechanisms. Bhatt and Grover (2005) used the term relationship infrastructure, which they defined as "the extent to which IT groups and line management trust, appreciate, consult with, account for, and respect each other in setting business and IT strategy". They found relationship infrastructure to significantly affect competitive advantage. The results also indicate a moderating effect of social capital on the relationship between IT capabilities and business agility (Quote 2-13, 4-14). As long as there is a lack of data quality or data transparency in IS, people use their social capital as an informal workaround for IT. The relatively low levels of IT agility and relatively high level of business agility in Case 4 (see Figure 6.10) can be explained by the existence of strong bonding and bridging social capital. It appears that people use their social capital to mitigate a lack of IT agility. This results in the following proposition:

***Proposition 5**: Social capital is an important moderating variable in the relation between IT capabilities and business agility*

Sensing overload and bounded rationality

Sense-making increasingly becomes an important element in the SRL-cycle. More data is generated and acquired via customers and partners. How to analyze and filter this data? How can existing organizational memory help to find threshold values? A challenge for companies like IBM is that there is not a shortage of ideas. The problem is that a lot of ideas do not get the attention or resources that are needed, because there are simply too many ideas and people do not know how to filter them. This refers to sensing overload. Human capabilities for data processing and analysis have their limits. When the number of alternatives to evaluate exceeds human processing capabilities (a case of sensing overload), managers use only a subset of these alternatives and often end up making sub-optimal decisions (Sengupta and Masini 2008). IT capabilities can support human data processing capabilities and decision making to overcome sensing overload, as was illustrated in Case 1 (use of social network analysis tools), Case 2 and 4 (use of agent software to monitor equipment and trigger a response in case of abnormalities) and Case 3 (text mining software for analyzing, filtering and ordering of jamming results). IT capabilities can also help in sensing innovation opportunities, which was illustrated via the TAP program and Jamming in Case 3 (see Quote 3-11). The cases provide evidence on how IT can mitigate sensing overload with positive effects on business agility. This results in the following proposition:

***Proposition 6**: IT capabilities can mitigate sensing overload by supporting human data processing capabilities and human decision making*

Limitations of human data processing capabilities should be taken into account in the design and use of IT tools to mitigate sensing overload. Otherwise, IT capabilities themselves might lead to sensing overload, as quote 3-8 and the following quote illustrate.

"The richness of the available IT tools within IBM has its limitations. Sometimes you cannot see the forest because of the trees. You can offer so much functionality, that you know that it is available somewhere, but you do not know where it is available. The same issue applies to availability of information. In this respect the search engine that we have available on our intranet might be improved" ***Quote #5-2, Consulting partner, IBM Benelux***

Therefore, IT capabilities and data should be offered modularly and with customization, based on the needs of individual users. New applications (like advanced search engines and agent technology) and a change in end-user IT usage skills and behavior (like selective usage of different media for different purposes) can help to reduce sensing overload.

Research Question 2: Is there a relationship between the type of event uncertainty and the use of sensing, responding and learning capabilities?

The empirical analysis of the four cases shows that depending on the type of uncertainty of the event, specific information types need to be sensed. The case study organization uses specific dynamic capabilities to sense and respond to different types of uncertainty. This is illustrated in Figure 6.11. The relationship between the three types of uncertainty and the use of different dynamic capabilities will now be explored in more detail, based on the four case studies.

Case 1 (Resource deployment) relates to responding to events with limited levels of uncertainty. Time/location uncertainty is relatively low, since resource requests are available at an early stage in Siebel and Demand Capture. When the opportunity becomes more concrete and a response is required quickly, the opportunity is moved to the Professional Marketplace. Only in the event of *ad hoc* demand (like the sudden departure of a candidate) is there some degree of time/location uncertainty. In the response process, knowledge can be codified and re-used to a large degree, therefore organizational memory IT is important.

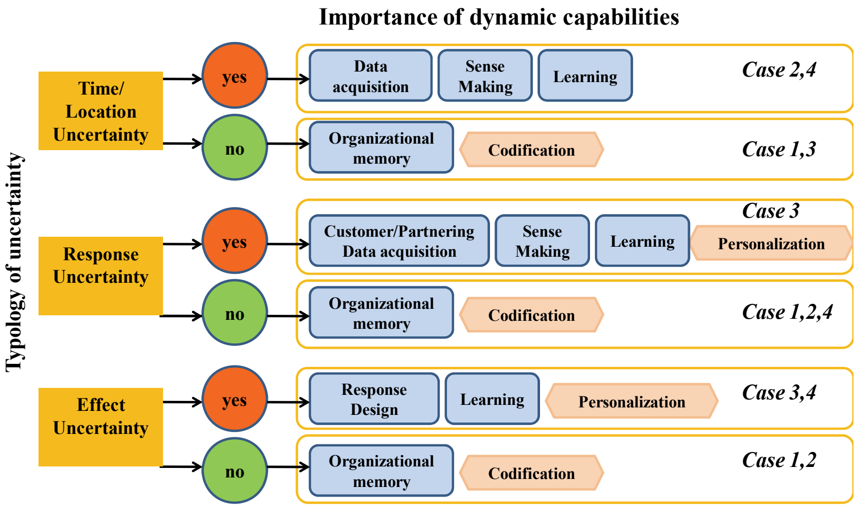

Figure 6.11 - Typology of uncertainty and importance of dynamic capabilities and knowledge management strategies

Case 2 (MTS) provides an example of responding to time/location uncertainty. It is relatively uncertain, when and where maintenance and support will be required for customers' equipment (e.g. the IceSafe event). Firms can reduce time/location uncertainty, by investing in sensing capabilities, especially acquisition of data from different sources and the capability to make sense of the data and initiate a response, in case there are deviations from threshold values and (expected) disruptions. By improving sensing capabilities, response can move from a reactive to a pro-active mode. Knowledge can be codified and re-used, since the cause-effect relationship between equipment, disruptions and possible solutions can be re-used (no response uncertainty).

Case 3 (Jamming and Centre of Excellence for Water Management) provides an example of responding to an event with response and effect uncertainty. The exact outcome of the jamming sessions, the required response and the impact of the new business model for the Centre of Excellence for Water Management on the IBM organization was not clear beforehand. Response design and learning capabilities can help to reduce effect uncertainty. With response design capabilities, the possible impacts of new business models can be simulated and evaluated. Learning helps to improve response design. The virtual collaboration research lab is an important tool to learn. Response uncertainty can be reduced by involving customers and partners (crowd sourcing) and by improvements in sense-making (data assimilation and filtering). The knowledge which is required to respond in the business development phase is to a large degree tacit, based on the usage of previous expertise and experience with innovation processes. This requires a personalization knowledge management strategy. There is an important role for information dissemination IT to support bridging social capital, especially to support the matching of opportunities with available expertise within IBM and partners of IBM. In the project execution phase there is a larger role for (declarative) organizational memory IT in case explicit knowledge stored in the IBM Knowledge DEAL databases can be re-used.

Case 4 (BCRS) provides an example of responding to an event with high levels of time/location uncertainty and high levels of effect uncertainty. The IBM BCRS unit is specifically designed to respond to such events. The timing and location of an emergency are uncertain. Also the nature of the impact of an emergency on the organization is uncertain to a large degree. This can lead to unpredictable outcomes. Dealing with events in this category requires a strong focus on sensing (data acquisition) and sense-making (diagnostic capabilities). Response design and learning capabilities can help to reduce effect uncertainty. IBM BCRS uses extensive testing and simulations to learn about the potential effects of possible emergencies, develop and improve response designs. Once the type of event and nature of the impact is clear, the organization can fall back to routine and experience with different types of response designs. The knowledge which is required in Case 4 is to a large degree tacit, since the case relates to highly personalized service offerings and a response based on previous experience in dealing with calamities (see Quotes 4-4 and 4-12). This tacit knowledge is used during sense-making, response design and in the selection of codified knowledge from organizational memory.

Previous research stated that one of the key challenges in increasing business agility is the degree to which tacit knowledge and ideas can be codified (i.e. transformed into effective and scalable action), so that others can understand, mobilize and take action when an opportunity arises (Welborn *et al.*, 2005). The cross-case analysis confirms that codification of knowledge supports sensing, responding and learning capabilities (Quotes 1-5, 3-9, 4-10, 4-11). A more detailed analysis of the different types of event uncertainty indicates that two types of knowledge management strategies are used for enhancing business agility, dependent on the level of event uncertainty. This yields the following propositions:

***Proposition** 7a: Responding to events with low levels of uncertainty is driven to a large degree by the exploitation of explicit knowledge from organizational memory and a codification knowledge management strategy.*

Proposition 7b: *Responding to events with high levels of uncertainty is driven to a large degree by the exploitation of tacit knowledge and a personalization knowledge management strategy.*

A more detailed analysis of the relationship between the type of event uncertainty and the use of specific capabilities gives us the following two propositions:

Proposition 8a: *Event uncertainty can be reduced by learning capabilities.*

Proposition 8b: *Time/location uncertainty and response uncertainty can be reduced by sensing capabilities.*

Research Question 3: How do sensing, responding and learning capabilities influence business agility performance?

The cross case analysis provides an indication, that higher levels of sensing, responding and learning lead to higher levels of business agility performance (see Figure 6.10). The effects of sensing, responding and learning capabilities on business agility performance for the four case studies are discussed in Appendix H.

In Case 1, the use of Professional Marketplace tools has increased the business agility performance of IBM in resource deployment. This generated huge cost savings (optimizing the use of human resources) and the ability to quickly respond to new opportunities by improving the matching process and increasing the response range via sourcing of resources from external partners. In Case 2 IBM uses customer agility to increase its sensing capabilities. This was accomplished via the use of electronic services and electronic agent software, installed on customers' equipment. This helped IBM MTS change its response from a reactive mode to a more pro-active mode. Via agent software, disruptions can be sensed by comparing actual values with threshold values in organizational memory. In this way, disruptions are detected before they actually occur. Via pro-active support, concrete cost savings can be realized, which improves business agility performance (see quote 2-17). The quick-connect with external suppliers of equipment increases response range and makes IBM MTS more agile in relation to its competitors. Case 3 presents some examples, where high levels of entrepreneurial agility have led to first mover advantages in the market of water management. In this domain, IBM is one of the first IT organizations to deliver services based on its expertise in sensor technology, information management and business continuity and resiliency. The case describes the use of Jamming technology for crowd-sourcing to increase the speed and quality of new idea generation.

In Case 4, IBM BCRS offers pro-active measures to increase customers' agility to respond to emergencies on the basis of consultancy (reducing risks on the customers' site), remote data backup and extensive training for and testing of emergencies together with customers. If an emergency occurs, the customer and IBM staff are well prepared to respond. The move towards a more pro-active response mode makes IBM BCRS (and their customers) more agile compared to competitors, with positive effects on business agility performance.

When a specific relationship is found between the business agility dimensions (sensing, responding or learning) and the business agility response metric (timeliness, ease, range or quality) in at least three of the four case studies, we can fairly generalize that relationship. Figure 6.12 shows the relationships between business agility dimensions (sensing, responding and learning) and business agility performance (metrics) that were found in at least three of the four cases.

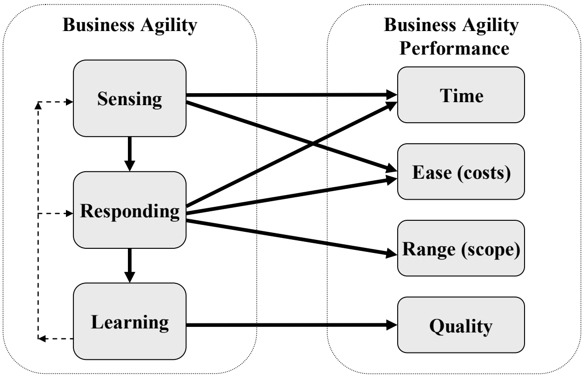

Figure 6.12 – Relationships between sensing, responding and learning and business agility performance

This analysis gives us the following proposition:

Proposition 9*: The combination of sensing, responding and learning capabilities is required to increase all dimensions of business agility performance.*

6.6 Conclusions and limitations

Conclusions

This study confirms previous research on the supporting role of IT capabilities for increasing business agility under certain conditions (e.g. Overby *et al*., 2006; Ross *et al*., 2006). To a large degree this depends on the enterprise architecture maturity, specifically standardization, data quality and data sharing, and how the architecture supports a firm's sensing, responding and learning capabilities. Lack of alignment among individual sensing, responding and learning capabilities and between business and IT among the different layers of the enterprise architecture explains differences in business agility performance. The analysis showed that IBM is relatively weak in SRL alignment (cross linking among IT capabilities). This can be explained by the current state of the enterprise architecture (many business silos). Existing business processes are often embedded in the existing IS and the mix of global enterprise-wide IS with local IT creates a complex IT architecture, which makes adaptation and renewal challenging (business-IT misalignment). The case-study evidence also indicates how IT capabilities can mitigate sensing overload by supporting human data processing capabilities and human decision making. Social capital is an important moderating variable in the relation between IT capabilities and business agility. As long as there is a lack of data quality or data transparency in IS, people use their social capital as an informal turnaround for IT. Social capital can mitigate the negative effect of low levels of IT agility on business agility performance.

The existing Sense-Respond framework for business agility (e.g. Overby *et al*., 2006) has been extended with learning as a third group of dynamic capabilities (like Dove, 2001). The empirical results confirm the importance of codifying knowledge to support business agility. In the IBM case studies, learning capabilities are required to codify and (on demand) activate knowledge, which feeds sensing- and responding capabilities. Learning is used as a feedback mechanism to align business agility need with business agility performance, to develop and improve sensing and responding, to keep knowledge levels up to date and to avoid unlearning. IBM uses a combination of two knowledge management strategies: codification (exploiting explicit knowledge stored in databases) to respond to events with low levels of uncertainty and personalization (exploiting tacit knowledge and social capital of people) to respond to events with high levels of uncertainty. The choice among these two approaches depends to a large extent on the degree to which knowledge can be codified, the degree to which people are able and willing to share their knowledge and the type of uncertainties that need to be responded to.

Limitations

This research, on the relationships between event uncertainty, IT capabilities, business agility and business agility performance, has six limitations. First, the four case studies that were analyzed are within the same company context. Case 4 (BCRS) relates to a business unit that is specifically designed for dealing with highly unpredictable and uncertain events. Therefore it is difficult to compare this case to regular companies dealing with such type of uncertainty. However, the research model itself is generalizable.

A second limitation refers to the time element. Case 1, 2 and 4 present a snapshot in time. Future research may consider a longitudinal research design to better assess how organizational antecedents affect business agility performance over time. For instance Case 1 would have yielded different results, if the analysis had been conducted as a longitudinal study. In such a study business agility performance could have been measured and compared in a situation without the professional marketplace and the current situation, where the professional marketplace has been implemented. This would have shown clear differences on IT agility, business agility (performance) and business performance (i.e. cost reductions) over time.

A third limitation is the comparability of the four case studies. Case 1 is not fully comparable with Cases 2, 3 and 4, since Case 1 relates to an internal department with internal customers that supports other units within IBM. Cases 2, 3 and 4 relate to departments with external customers. This makes some constructs, such as customer agility, difficult to analyze and measure for Case 1.

A fourth limitation comes from the organizational position of the participants in the case study. Interviews were conducted with managers at a local (business unit) level, which might provide some subjectivity and bias in the outcomes. Due to time- and budget restrictions it was not possible to conduct interviews at the corporate level. This might lead to a one-sided perspective on the role and impact of IT capabilities, since IT capabilities are to a large extent centralized in the IBM organization.

A fifth limitation stems from the type of events analyzed in the four case studies. These events are to a large degree within the range of expectations of the different units. Were these events really testing the agility of the units or were they testing their operational adaptability (Sambamurthy and Zmud, 2004) and standard response processes? It would be interesting to analyze more extreme event types (type 6-7-8) outside the range of expectation and analyze how IBM as a whole is able to sense, respond, and learn when there is no information on the event available in the organizational memory (i.e. response uncertainty).

A sixth limitation refers to the measurement instrument. The measurement instrument was developed to analyze maturity of individual IT capabilities, business capabilities, and business agility performance. The variables and items were adapted from existing survey instrument scales to measure the maturity levels of individual sensing, responding and learning capabilities. The measurement instrument was used to support the qualitative analysis of the researcher in the comparison of the four case studies. It was not used to quantify constructs or statistically analyze relationships (correlations) between constructs based on a representative sample of respondents from the four cases. A more developed measurement instrument could have made the argumentation stronger. The current instrument does not measure relationships among capabilities or portfolios of capabilities. Business agility performance (in time) depends to a large extent on the degree to which learning has a feedback loop into (improving) sensing and responding. This mutual dependence should be incorporated into a future refined version of the measurement instrument.

Chapter 7: Conclusion

7.1 Introduction

This dissertation is the result of several years of research and a combination of different empirical studies on the relationship between IT capabilities, business agility and business agility performance. Section 7.2 summarizes the key findings of this dissertation. In order to answer the study's central research question, the eight sub-questions are summarized first. Second, the central research question is answered based on the answers of the sub-questions. Section 7.3 discusses the scientific and managerial implications of this study. This chapter concludes with the research limitations and suggestions for future work (section 7.4) and some concluding remarks (section 7.5).

7.2 Synthesis of the Findings

7.2.1 Research questions

To answer the study's central research question, eight sub-questions were posed. Below, their separate outcomes are summarized.

Research Question 1: *How can business agility and business agility performance be defined and measured? (Chapter 2)*

Business agility is defined as *the ability of an organization to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected but potentially consequential internal and external events, based on the capabilities to sense, respond and learn.* Business agility performance is defined as *the performance of an organization to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events*. This is a multi-dimensional concept that can be assessed and measured in terms of four change proficiency metrics (Dove, 1995; Dove, 2001): (i) response time(liness), (ii) response cost, (iii) response quality or robustness and (iv) response range.

Research Question 2: *How can (a lack of) business agility performance be explained? (Chapter 2)*

The literature review reveals two alignment types that explain (a lack of) business agility performance from an IT perspective. Sense-Respond-Learn (SRL) alignment refers to *the maturity, balance and relationship between sensing, responding and learning capabilities*. Business-IT alignment refers to *the alignment between business and IT and the alignment* *between the different layers of the enterprise architecture*. Firms that score *high* on SRL alignment and also score *high* on Business-IT alignment are expected to have *high* business agility performance levels. These firms are able to sense disruptions or opportunities, respond quickly and learn from each event to improve sensing and responding. The IT of these firms is aligned with the business. In the event that modifications are required, in both processes and IT (as part of the response process), the changes can be made with relative ease and speed. Firms that score *low* on SRL alignment and also score *low* on Business-IT alignment will have a *low* business agility performance. Firms that score *low* on SRL alignment or on Business-IT alignment, while scoring *high* on the alternate alignment dimension will have *medium* business agility performance. Business agility performance is also influenced by personal and organizational constraints and rigidities. Examples of organizational constraints are rigid organizational structures and incentive systems, organizational culture that restricts learning and knowledge sharing and a lack of empowered of employees. Examples of personal constraints are cognitive and emotional biases and existing mental models, which can bias the process of sensing, responding and learning.

Research Question 3: *Which events cause a business agility gap (i.e. for which events do firms perceive a deficiency in the required level of business agility performance) and is there a difference between different industries? (Chapters 4,5)*

In the field studies (Chapter 4 and 5), events with external and internal origin were identified that cause a lot of uncertainty and require high business agility performance of firms. Agility was required when existing flexibility was perceived to be insufficient and the event was uncertain in time or location, response and/or effect. Four types of events were identified that caused the highest levels of uncertainty compared to a perceived deficit in business agility performance as reported by managers. First, price wars and the need for lower priced products & services cause high levels of time/location- and effect uncertainty. Second, fast changing customer demands create high levels of time/location-, response- and effect uncertainty. Firms are challenged by a lack of SRL alignment and business-IT alignment in coping with the required changes. In many cases it requires a totally different way of organizing the business and (partnerships in) the business network. Third, governmental regulation and deregulation causes high levels of response- and effect uncertainty and a need for business agility in almost all sectors analyzed. Fourth, many internal events (such as mergers and acquisitions, organizational restructuring, changes in sourcing strategy) contain high levels of effect uncertainty. The empirical research revealed a deficit of business agility performance levels to respond to these internal events.

Research Question 4: *How do IT capabilities impact business agility? (Chapters 2-6)*

The empirical studies (Chapters 4 and 5) provide evidence that the IT landscape of many large service organizations can be characterized as heterogeneous, consisting of older legacy systems, different enterprise systems and more recently developed information systems. This diffuse IT landscape has evolved due to mergers, acquisitions and reorganizations. This has led to low levels of connectivity and standardization, limited data transparency and complex architectures. Older legacy information systems often lack up-front reconfigurability (because business rules are embedded) and are vertically integrated (with tightly coupled presentation, logic and data). Such a heterogeneous IT landscape with relatively low levels of enterprise architecture maturity creates high costs for maintenance and integration and leaves little room for renewal and innovation. This results in a lack of alignment among business and IT, a lack of alignment among sensing, responding and learning capabilities and ultimately the IT hampers business agility.

In Chapter 2 three streams of literature were identified with different perspectives on the relationship between IT capabilities and business agility (performance). The empirical research in Chapter 6 of this dissertation gives support to the second stream of research. IT capabilities can support business agility, but only to a certain extent and under the condition that sensing, responding and learning (IT) are aligned with each other, and business capabilities are aligned with IT capabilities among the different layers of the enterprise architecture. The case evidence also indicates how IT capabilities can mitigate sensing overload by supporting human data processing capabilities and human decision making. The empirical research in Chapter 6 reveals that social capital is an important moderating variable in the relationship between IT capabilities and business agility. Social capital can mitigate the lack of IT agility that exists in many organizations by overcoming information system boundaries and rigidities via human relationships.

Research Question 5: *Which elements comprise the (transition towards) an agile IT architecture?(Chapter 4)*

Agile IT architectures are characterized by highly standardized IT components with network connectivity and hardware compatibility. An agile architecture is based on simplification with reconfigurable and modular components. This facilitates easy modifications, scalability and a quick-connect to the capabilities of external partners and customers. High levels of data quality and data sharing are important components of agile IT architectures. The technology foundation that provides the basis for an agile IT architecture incorporates Business Process Management (BPM), business analytics, Service-Oriented Architectures (SOAs), and Event-Driven Architectures (EDAs) to couple sensing, responding and learning. Finally, an agile IT architecture supports the codification and exploitation of knowledge on the one hand and a personalization knowledge management strategy with improvisational capabilities on the other hand.

Research Question 6: *What IT strategies exist for enhancing business agility?(Chapter 5)*

Depending on the level of maturity of business and IT capabilities, the need for business agility, and the level of uncertainty of events that firms must respond to, different IT strategies were proposed in Chapter 5. The first IT strategy refers to firms operating in an environment with relatively low levels of uncertainty, which are perceived to be sufficiently agile. In these settings, the IT strategy can focus on increasing sensing capabilities to be prepared for possible changes in the environment and learning capabilities to activate explicit knowledge on-demand from organizational memory IT. The second and third IT strategies address firms that operate in an environment with a high business agility need, which are perceived to lack business agility performance. In the second IT strategy, IT agility is increased by developing and linking sensing-, responding- and learning IT capabilities. These capabilities should be developed on a highly standardized IT infrastructure, based on global standards and high levels of data quality and data sharing, while leaving room for local responsiveness. In the third IT strategy, IT is used to neutralize the need for business agility.

Research Question 7: *Is there a relationship between the type of event uncertainty and the use of sensing, responding and learning capabilities?(Chapter 6)*

The research in Chapter 6 provided support for the idea that codification of knowledge supports business agility. Responding to events with low levels of uncertainty is driven to a large degree by the exploitation of explicit knowledge and a codification knowledge management strategy. Responding to events with high levels of uncertainty is driven to a large degree by the exploitation of tacit knowledge and a personalization knowledge management strategy, which is linked to the social capital of people. Firms need to decide on a balance and mix of codification knowledge management strategies (linked to codified explicit knowledge in organizational memory IT) and personalization knowledge management strategies (linked to tacit knowledge and the social capital of people).

The research in Chapter 6 suggested differences between the type of perceived uncertainty (time/location-, response- and effect uncertainty) and how these differences influence the use of sensing, responding and learning capabilities. Time/location uncertainty and response uncertainty can be reduced with sensing and learning capabilities. Response uncertainty can be reduced by tapping into external intelligence (customer and partner sensing capabilities) and sense-making capabilities (data assimilation and filtering). Effect uncertainty can be reduced with response design and learning capabilities. With response design capabilities possible impacts can be simulated and evaluated, before an actual response decision is taken.

Research Question 8: *How do sensing, responding and learning capabilities influence business agility performance? (Chapter 6)*

The case studies in Chapter 6 provide evidence that a combination of sensing, responding and learning capabilities is required to increase all dimensions of business agility performance. The cases suggested relationships between higher levels of sensing capabilities and shorter response times and lower response costs. The results also suggested a relationship between higher levels of responding capabilities and shorter response times, lower response costs and a wider response range. Finally, the case studies indicated a relationship between higher levels of learning capabilities and a higher response quality. The results also suggested an indirect effect of learning capabilities on response time, response cost and response range via the effect of learning capabilities on sensing and responding.

7.2.2 Central research question

The outcome of the eight sub-questions discussed in section 7.2.1 offers the information to proffer a balanced answer to the study's central research question. Recapitulating, the main research question is as follows:

What is the role and impact of IT on business agility of service organizations in response to uncertain events?

The empirical studies in Chapters 4 and 5 provide evidence that the IT landscape of many large service organizations can be characterized as heterogeneous, consisting of older legacy systems, different enterprise systems and more recently developed information systems. This diffuse IT landscape has emerged during the years due to mergers, acquisitions and reorganizations. This has led to low levels of connectivity and standardization, limited data transparency and complex architectures. Such a heterogeneous IT landscape with relatively low levels of enterprise architecture maturity creates high costs for maintenance and integration and leaves little room for renewal and innovation. This results in a lack of alignment between business and IT, a lack of alignment among sensing, responding and learning capabilities and ultimately the IT hampers business agility.

The empirical research in Chapter 6 indicates that IT capabilities can support business agility in response to uncertain events, but only to a certain extent and under the condition that sensing, responding and learning (IT) are aligned among each other, and business capabilities are aligned with IT capabilities among the different layers of the enterprise architecture. The research provides insight into the conditions under which IT capabilities support higher levels of business agility. Standardization of IT capabilities coupled with higher levels of data quality, support higher levels of business agility. Higher levels of enterprise architecture maturity support higher levels of business agility. Social capital is an important moderating variable in the relationship between IT capabilities and business agility. Social capital can mitigate the lack of IT agility that exists in many organizations by overcoming information systems boundaries and rigidities via human relationships.

Organizing processes and IT based on SRL and improving SRL alignment and Business-IT alignment only makes sense if the firm has a high business agility need. A distinction was made between the types of uncertainty that can accompany an event including time/location uncertainty, response uncertainty and effect uncertainty. The more uncertainties a business must deal with, the more important SRL alignment and business-IT alignment becomes, and the more important it is to close any gaps. Chapter 6 provided evidence that the amount and type of uncertainty has implications for the role and impact of IT on business agility. The type and degree of uncertainty associated with an event influences the use of a knowledge management strategy and the IT capabilities that support it. A codification knowledge management strategy drives the response to events with relatively low levels of uncertainty by exploitation of explicit knowledge from organizational memory. Important IT capabilities that support a codification knowledge management strategy are tools for capturing, storing and exploiting knowledge. A personalization knowledge management strategy drives the response to events with relatively high levels of uncertainty by exploitation of tacit knowledge and social capital of people (Hansen, 1999; Boisot, 1999). Important IT capabilities that support a personalization knowledge management strategy are communication tools, tools for social network analysis, tools that support improvisation and learning and tools that enable crowd sourcing.

7.3 Implications

7.3.1 Scientific contributions

In Chapter 2 we distinguished four literature streams and perspectives on the concept of agility (manufacturing perspective, organization and strategy perspective, supply chain perspective and IT perspective). This dissertation contributes to the organization and strategy perspective (Conboy and Fitzgerald, 2004; Sambamurthy and Zmud, 2004; Dove, 2005; Overby *et al.*, 2006) by developing a more elaborate definition of business agility and its components. Building upon and extending the ideas of Overby *et al*. (2006) this research breaks the complex business agility construct into its constituent parts. Learning capabilities are added as an important dynamic capability buttressing sensing and responding capabilities. These three groups of dynamic capabilities are further partitioned into a sense-respond-learn (SRL) framework made up of twenty dynamic capabilities. Rather than attempting to investigate how factors affect business agility in general, this thesis suggests that it is more fruitful to investigate how individual capabilities affect sensing, responding and learning within firms and how these capabilities are related. The SRL-framework is also useful for examining how IT supports sensing, responding and learning. The SRL-framework illustrates the symbiotic relationship between sensing, responding and learning. The framework is also used to analyze the relationship between different types of uncertainty, the importance of individual capabilities and the relationship between sensing, responding and learning as measured against different business agility performance metrics. In Chapter 6 an initial version of a measurement instrument is developed and validated. This instrument measures maturity levels for each of the different dynamic capabilities.

In Chapter 2, we distinguished three literature streams on the relationship between IT capabilities and business agility. This dissertation contributes to the second stream of literature, which states that IT capabilities contribute to higher levels of business agility (performance) under certain conditions and for certain events (Bhatt *et al*., 2005; Overby *et al.*, 2006; Ross *et al*., 2006; Aral and Weill, 2007; Tallon, 2008). This dissertation establishes a framework on alignment, which explains the conditions under which IT capabilities support business agility (performance). The framework builds upon the existing theory of business-IT alignment and supplements it with alignment among sensing, responding and learning. Previous research primarily used the structural IT design perspective towards IT agility, which measures agility of IT based on design criteria like modularity, connectivity and compatibility of the IT infrastructure and IS (for example Byrd and Turner 2001). This research analyses IT agility from the perspective of how it supports, enables and cross-links sensing, responding and learning in the different layers of the enterprise architecture. Agility should be incorporated in each layer of the enterprise architecture with alignment among the different layers of the architecture (business-IT alignment).

Another addition to the existing literature on the relationship between IT capabilities and business agility is the moderating role of social capital. Previous research paid relatively little attention to the people and social side of business agility while overstating structural and IT aspects. The empirical case studies confirm that IT capabilities are a necessary, but not sufficient condition for business agility. The empirical research in this dissertation reveals that social capital is an important moderating variable in the relationship between IT capabilities and business agility. People use their social capital to (partly) mitigate the lack of IT agility, found in many organizations. The level of (informal) connectedness (i.e. the personal relationships and network) is an important element in sensing, responding and learning. This applies both in situations that require adaptive agility and in situations that exploit entrepreneurial agility, which was illustrated in the four different case studies of Chapter 6.

7.3.2 Managerial implications

This dissertation has a number of important implications for managers. In the current marketplace firms increasingly need to collaborate in networks of partners. Competition moves from the organization to the network. Such networked organizations require new business models based on business agility to sense and respond quickly to highly uncertain events, which can be either threats or opportunities in the business environment. In these dynamic networks, quick-connect and data sharing with (changing) business partners becomes a necessity in order to succeed as a business over time.

The research shows that IT architecture and IT capabilities can be an important means for enhancing business agility (see case studies in Chapter 3). This requires standardization of IT, high levels of data quality and data sharing (see Chapters 3 and 6). IT capabilities can mitigate sensing overload by supporting human data processing capabilities and human decision making. The empirical studies in Chapters 4 and 5, however, teach us that in many organizations, the inheritance of legacy systems and complex IT architectures are a major problem, hampering business agility performance and causing business agility gaps. The reasons behind these gaps include a lack of standardization, a lack of data quality and a lack of data sharing (Chapters 4 and 5). A lack of alignment between business and IT hampers business agility performance. In many organizations, IT is organized per department or for each functional area (i.e. as business silos). This dissertation confirms previous research that higher levels of enterprise architecture maturity support higher levels of business agility performance (Ross *et al*., 2006). In addition, the results suggest that managers should (re)structure their IT into an interdependent cycle that supports sensing, responding and learning across the firm.

More specifically, managers can pursue two strategies to deal with the business agility gaps. First and foremost, firms should focus on increasing their external agility and organizing their IT to support this. This requires standardization of interfaces, quick-connect capability and sharing of data, based on standard data formats and semantics. This strategy enables firms to connect to the capabilities of external partners, co-opt their customers in the SRL cycle and exploit crowd sourcing. Second, managers need a transition mechanism for the existing internal legacy systems, which cannot be replaced easily or quickly. One transition strategy is to create a layer on top of the existing legacy systems, based on a service oriented architecture and to use business process management and an event driven architecture to increase agility. In parallel, organizations need to work on maturing their enterprise architecture. Essential elements include creating a shared IT infrastructure, developing and maintaining standards for interoperability, creating semantics and standards for data sharing and modularizing IS and business processes. In this way, business silos can gradually be replaced with modular service based architectures, which provide a better basis for business agility (Ross *et al.*, 2006). If a firm moves towards higher levels of enterprise architecture maturity, this will enable higher levels of business agility performance on a local (business unit) level and global (enterprise) level. The enterprise architecture should be designed in such a way that it optimizes SRL alignment and business-IT alignment.

In addition to carefully planning IT design managers should take great care to consider the social, people-related perspective in relation to improving and enabling business agility. In particular, managers should be cognizant of developing opportunities to increase social capital by creating a culture based on trust and empowerment that stimulates knowledge sharing and informal connectedness. These are important means to close the business agility gaps and increase business agility performance. Social capital can be used to mitigate a lack of IT agility. Personal relationships (i.e. connectedness) between business and IT people are an important means to informally improving business-IT alignment and therefore business agility performance. In the implementation of SRL within the firm, managers need to be aware of personal and organizational biases and rigidities that can limit or even restrain higher levels of business agility performance.

Finally, managers should carefully consider how knowledge management and learning can help firms to respond to various types of uncertainty. A codification knowledge management strategy drives the response to events with relatively low levels of uncertainty by exploiting explicit knowledge from organizational memory. Another approach is the personalization knowledge management strategy, which can be used to respond to events with relatively high levels of uncertainty by exploitation of tacit knowledge and social capital. The choice among these two approaches depends to a large extent on the degree to which knowledge can be codified, the degree to which people are able and willing to share their knowledge and the type of uncertainties that need to be responded to. The choice of a knowledge management strategy has implications for the importance of different IT capabilities and the design of the enterprise architecture. Important IT capabilities supporting a codification knowledge management strategy are tools for capturing, storing and exploiting knowledge. Important IT capabilities that support a personalization knowledge management strategy are communication tools, tools for social network analysis, tools that support improvisation and learning and tools that enable crowd sourcing.

7.4 Reflection, limitations and future work

7.4.1 Reflection

Business agility appears in various literature streams. It started in the manufacturing literature in the early nineteen-nineties and was later extended to supply chain management, marketing, strategy and IS. In this dissertation a multi-disciplinary perspective was developed on the relationship between IT capabilities, business agility, and business agility performance, based on concepts across multiple streams of research.

There are two tensions related to the concept of business agility. From the one side, there are three streams of literature with different perspectives on the relationship between IT capabilities and business agility (performance). One stream claims that IT is a necessary condition for higher levels of business agility performance. The second stream claims that IT contributes to higher levels of business agility performance under certain conditions and for certain events. The third stream of literature claims that IT does not really matter in achieving superior business agility performance. This literature stream criticizes the degree to which IT can bring sustainable benefits, due to its rigidity and complexity. We found no direct relationship between IT and business agility performance (i.e. the first literature stream). The empirical results provided evidence that the relationship is mediated by sensing, responding and learning capabilities. At first, our evidence seemed to support the third literature stream. In many service organizations we found a hampering effect of IT on business agility (Chapters 4 and 5). A closer look at the IT-agility relationship in Chapter 6 revealed, however, that IT can contribute to higher levels of business agility performance under the conditions of higher levels of enterprise architecture maturity (i.e. more standardization and data sharing), high levels of data quality, strong alignment between business and IT capabilities and alignment among sensing, responding and learning. These conditions explain why a lot of service organizations still have difficulties organizing IT as a means to enhance business agility.

On the other side, there is a tension in the applicability of the business agility concept to the service industry. The concept of business agility originated from the manufacturing industry. As such, one can question the degree to which business agility applies to the service industry. There are a number of fundamental differences between service organizations and manufacturing firms, such as the intangible and perishable nature of the output and the closeness of the consumer to the producer (Mills and Margulies 1980). These differences have implications for the relationship and role of IT capabilities on business agility and business agility performance. In service industries people use time as an input to deploy knowledge assets, collaboration assets, and process-engagement to create productivity (effectiveness), performance improvement (potential) and sustainability. Typically the output of service organizations is content (information), service, attention, advice, experiences, and/or discussion ("intangible goods"). The quality of most services depends to a large extent on the quality of the individual that provides the service. Service employees can be seen as "mini-factories" (Mills and Margulies, 1980). Therefore, in the delivery of services, IT support for agility refers mainly to the empowerment of individual people in their service delivery process; while in the design and manufacturing of physical products, IT support for agility refers mainly to the capability of the firm to embed agility in the design of products and resources. A comparative study of the commonalities and differences between manufacturing firms and service organizations, in relation to the role of IT capabilities and the effects of sensing, responding and learning on business agility performance, would be a worthwhile addition to the body of knowledge.

Mills and Margulies (1980) present a typology of service organizations based on seven underlying dimensions of the interface between clients/customers and service organizations. They distinguish between maintenance-interactive, task-interactive and professional-interactive service organizations. Task-interactive service organizations operate in dynamic environments, which require novel solutions to unusual and unique problems. On the contrary, maintenance-interactive service organizations operate in relatively more simple and stable environments with a lower degree of uncertainty for the employee. Personal-interactive service organizations operate in highly unstable and chaotic environments, with high change rates. This type of service organization is the most dynamic one. Each task and interactive episode requires novel solutions, with the decisions being made by the employee tending to be complex and judgmental. Depending on the type of service organization, differences are expected in the importance of various dynamic capabilities (in line with propositions 8a and 8b from Chapter 6) and in the importance of the two knowledge management strategies (in line with propositions 7a and 7b from Chapter 6).

7.4.2 Limitations

The research in this dissertation has six limitations. The first limitation is the research context. The research was to a large degree driven by practice oriented applied research projects in collaboration with and funded by the business community. This strengthens relevance of the research. A challenge in the execution of such projects is maintaining rigor, since time- and budget constraints as well as interests from a practical business perspective influence the research (process). Balancing rigor and relevance is a common concern in business research – this research was no different. A more elaborate discussion on rigor versus relevance for IS research can be found in (Benbasat and Zmud, 1999).

A second limitation is the generalizability of the research. The research focused on the analysis of large incumbent enterprises in the Netherlands. A distinction between pure

Internet based firms (such as eBay) versus brick-and-mortar firms might provide differences in the relationship between IT capabilities, business agility and business agility performance. Pure Internet based firms, in most cases, have a relatively young IT infrastructure enabling them to quickly adapt or innovate their business model and processes; while incumbent brick-and-mortar firms are faced with heterogeneous IT infrastructures that have evolved over time and often lack the capability to adapt or innovate quickly. This research also did not distinguish between small firms and medium to large firms. The portfolio of dynamic capabilities and the effects on business agility performance for large (possibly bureaucratic) firms will probably be different, compared to more modern or innovative (i.e. risky) ways of organizing work, such as self organized networks of knowledge workers. This research also did not analyze different levels of environmental dynamism as a moderating variable. Previous research (Tallon, 2008) has shown that environmental dynamism moderates the link between IT agility and business agility. Also cultural differences might influence the generalizability of the research. Finally, the research focused on firms providing services; no comparison was made with manufacturing firms.

A third limitation relates to the analysis of the case studies in Chapters 4 through 6. These studies were conducted as snapshot studies. Longitudinal research could provide more in-depth insight on the dynamics of the relationship among the different constructs. "*The nature of dynamic capabilities for which managerial and IT capabilities are quintessential forms due to their ability to respond to change calls for longitudinal analysis*" (Tallon, 2008). New IT takes time to be adopted and integrated in the organizational processes. Therefore the real (performance) effects will take place only after some time —beyond the introduction costs and learning effects.

A fourth limitation comes from the organizational position of the participants in the case studies. Interviews were conducted with managers at a local (business unit) level, which might provide some subjectivity and bias in the outcomes. Due to time- and budget restrictions it was not possible to conduct interviews at the corporate level. This might lead to a one-sided perspective on the role and impact of IT capabilities on business agility and the trade-off between (local) business unit business agility and enterprise wide (global) business agility.

A fifth limitation stems from the type of events analyzed in the four case studies in Chapter 6. These events are to a large degree within the range of expectations of the different units. Were these events really testing the agility of the units or were they testing their operational adaptability and standard response processes? It would be interesting to analyze more extreme event types (type 6-7-8) outside the range of expectation and analyze how service organizations as a whole are able to sense, respond, and learn when there is no information on the event available in the organizational memory (i.e. response uncertainty).

A sixth limitation refers to measurement of business agility performance. In Chapter 6 a measurement instrument was developed to analyze and measure perceptions on the maturity of individual IT capabilities, business capabilities, and business agility performance. The measurement instrument was used to support the qualitative analysis of the researcher in the comparison of the four case studies in Chapter 6. It was not used to quantify constructs or statistically analyze relationships (correlations) between constructs based on a representative sample of respondents. A more developed measurement instrument could have made the argumentation stronger. The research used the perception of managers to measure the role and impact of IT capabilities on business agility and business agility performance. The use of objective measurements (on response times, response costs, response quality and response range) to respond to specific events could have made the argumentation stronger.

7.4.3 Discussion of further work

This dissertation answered several questions, but it also raised many more. Six suggestions and recommendations for further work are discussed below. A first recommendation for further research is to conduct more case studies on the relationship between IT capabilities and business agility for different types of event uncertainty from the typology on event uncertainty in Chapter 6. Preferably, this analysis should include successful and non-successful cases to control for the type of event and be longitudinal in scope. This way the effects of IT capabilities on business agility and business agility performance can be analyzed over time. New IT takes time to be adopted and integrated into the organizational processes. Therefore the real effects will take place only after some time. In addition to a qualitative assessment of business agility performance, case studies should try to quantify response times, response costs, response quality and response range for different types of events at both the corporate and local business unit level.

A second extension to this research is the refinement of the agility measurement instrument. An initial version was developed, that analyzes the relationship between IT capabilities maturity, business agility maturity, and business agility performance. Future research can take this measurement instrument as a basis and convert it into a survey instrument, which can, in turn, be used for quantitative survey analysis. The number of variables should be reduced and inter-relations should be filtered to make it a scientifically sound measurement instrument. Nominal scales should be scaled back to their original ordinal 5-point scales. Based on the conceptual model (Chapter 6), other constructs such as enterprise architecture maturity might be added, to conduct a more comprehensive analysis. The current instrument measures maturity levels of individual capabilities. It does not measure relationships among capabilities or portfolios of capabilities. Business agility performance (in time) depends to a large extent on the degree in which learning capabilities have a feedback loop for improving sensing and responding capabilities. This mutual dependence should be incorporated into the measurement instrument.

A third recommendation for further research is the analysis of different types of business agility need and implications for the role of IT. The cases in Chapter 6 illustrate and discuss three types of business agility need from the classification of Ross (2008) -- business efficiency agility (Cases 1, 2 and 4), new product agility (Case 3) and business transformation agility (Case 3). More research is required to analyze these different types of business agility need and the portfolio of business and IT capabilities that best fits each type. It is very expensive to build an IT platform to support all these types of business agility need. Depending on the overall business strategy, certain types of business agility need can be more relevant than others. Thus more case studies on these different types of business agility need and other types of business agility need (such as boundary spanning agility) could serve to illuminate similarities and differences, requirements for IT and links among the different types of business agility need. For example, research of Ross (2008) has shown that if a firm builds a base for new product agility, it also has a base for new business models. It is expected that there will be different and sometimes conflicting requirements for enterprise architecture design and IT capabilities, depending on the type of business agility need.

A fourth line of new research pertains to the development of ideal portfolios of business and IT capabilities. This research could derive guidelines on when and how to balance the different capabilities. For example, is the business agility performance of a firm that scores '*medium*' on sensing, responding and learning better than the business agility performance of a firm that scores '*high*' on sensing and responding and '*low*' on learning? Most probably this depends on the type of uncertainty that a firm needs to respond to, the need for business agility and the level of development and maturity of the different capabilities. The effect of learning capabilities on sensing and responding will be relatively high in the development phase, where firms increase their business agility performance levels. Once a certain level of business agility performance has been achieved, the effect of learning capabilities on sensing and responding will be more moderate. In this phase, learning capabilities are required to avoid the unlearning of existing capabilities and keep existing performance levels and develop new capabilities if required.

A fifth extension includes a study of the trade-off between local (business unit) agility and global enterprise-wide agility, the implications for enterprise architecture design and the effects of recent approaches towards designing IT architecture. The recent approaches of interest include service based computing, Service Oriented Architectures (SOA) and

Business Process Management (BPM). The use of the sense-respond-learn cycle has major implications for the way the enterprise IT architecture is designed. Recent approaches to the design of IT architecture promise higher levels of IT agility and business agility performance. However, research of Ross (2008) shows that the use of SOA has not (yet) led to the intended agility levels for early adopters of SOA. More research is needed to analyze if and how SOA increases IT agility and supports a firm to sense, respond and learn with positive effects on business agility performance at both the local (business unit) level and the global enterprise level. This research can build upon recent work of Hirschheim *et al*. (2010) who develop a five stage maturity model for Service Oriented Architecture.

A sixth and final recommendation for further research is the development of measurements to disentangle the effects of technological design oriented factors and the effects of social factors on business agility performance. The empirical findings (Chapter 6) reveal that tacit knowledge and skills of people and their social capital are important factors that influence business agility performance. These findings are in line with research on social innovation (Volberda *et al*., 2005), which claim that technological innovation (i.e. R&D and IT investments) determines only 25% of innovation success, while social innovation (i.e. management, organization and work aspects) determines 75% of innovation success.

7.5 Concluding remarks

This dissertation urges organizations to change their organizational design, processes, culture and supporting IT according to the paradigm of sensing, responding and learning as a means to confront uncertain and unexpected, but potentially consequential internal and external events. Besides the well known requirement of alignment between business and IT, this thesis supplements it with alignment among sensing, responding and learning as two prerequisites for higher levels of business agility performance. Increasingly, IT can support firms and individuals with more advanced sensing, quick response to new events and learning from previous events. The processing power of IT is still increasing (Law of Moore). IT is continually evolving to be more standardized, open, modularized and mobile. Via communication technologies, people and machines are connected on a global scale. Intelligence and processing power moves to the local user and becomes accessible any place any time. Intelligent agent software supports decision-making while social networks and communities provide a source of intelligence. Firms collect increasingly detailed information about their employees, customers and partners. Products and resources are continuously tracked along global transport corridors until delivery and consumption at the final customer. One of the biggest challenges for firms is how to make sense out of this huge amount of information (i.e. deal with sensing overload), translate it into a local and global response and learn from it on a global scale. Personal and organizational biases and rigidities can blur this sense-making process. Firms and individuals need to be aware of their biases and open to changing their mental models. The IBM case study on water management illustrated that the use of social networks and crowd sourcing are mechanisms to mitigate existing biases and develop the necessary intelligence while improving sense-making to spot unforeseen opportunities, disruptions or more catastrophic events. As the empirical research and these examples have shown, there is still a lot of work to be done to increase business agility performance in service organizations. Innovative and new IT solutions challenge practitioners and scientists to develop new solutions and approaches.

APPENDIX

Appendix A: Comparison of corporate transformations

Table Appendix-A.1 – Comparison of corporate transformations (adapted from Sambamurthy and Zmud, 2004)

	Corporate Transformations			
Characteristics	**Total Quality Management**	**Lean Management, Mass customization & Six Sigma**	**Organizational Adaptiveness**	**Strategic Agility**
Competitive basis	Efficiency and Quality Economies of scale	Customer centricity & Product variety; Economies of scope	Flexibility and partnerships; Economies of expertise	Entrepreneurial sense-making and improvisation; Economies of learning
Design objectives	Customer satisfaction Asset utilization	Product modularization Process rationalization	Competency Unbundling; Value net leverage	Innovation and Disruption
Decision architecture	Internal Collaboration Process-Centric Cross-Functional Teams	Internal Collaboration Customer Centric Horizontal Integration	External Collaboration Solution-Centric Virtual integration	External/Internal Collaboration Market-Centric Distributed decision-making
Information architecture	Data rationalization Metrics Rationalization	Process rationalization Data integration	Meta process rationalization Meta data Integration	Information visibility Information probing
Strategic IT Role	Information-Down Automation	Informate-Across Informate-Up	Transform Business Processes & Practices; External Collaboration	Fluid Decision. Authority & Collaboration Structures
IT Architecture	Application Integration	Technology Standardization	Rationalized Data Core Process Integration	Modular Wired Business Core
Key technologies	Data Management, Real-Time Data Capture, Decision Support	Enterprise Data Process Modeling, EDI Collaboration Technologies	Enterprise Process Modeling, ERP, EAI, Web-enablement	Web Services & cloud computing Objects, Intelligent Agents, Distributed Collaboration Technologies / web 2.0
Key IT Partnerships	Internal Business Functional Experts	IT Service Providers, Internal Process Experts	Partners' IT and Process Experts; Internal Market Experts	Partners' Market Experts
IT Investment Focus	Cost Reduction	Productivity Improvement, Time-to-Market	Product Life Cycle Refreshment, Share of the Customer's Pocket	Real Options, Market Prototyping, Time-to-Solution, Relationship Capital

Appendix B: Agility measurement framework constructs

Table Appendix-B.1 – Constructs and variables of the agility measurement framework

Constructs	Sub-constructs and variables (with number of items)	Literature
Uncertainty	Type of Uncertainty - Response uncertainty (*) - State uncertainty (*) - Effect uncertainty (*)	Milliken, 1987
Sensing capabilities	- Internal Data acquisition (7) - Customer Data acquisition (9) - Partnering Data acquisition (8) - Data Assimilation (4)	Kohli *et al.*, 1993 Jaworski and Kohli, 1993 Tippins and Sohi, 2003
Responding capabilities	- Internal Response design (7) - Customer response design (3) - Partnering response design (3) - Internal decision-making (5) - Internal response implementation (8) - Customer response implementation (4) - Partnering response implementation (4) - Quick-connect (5) - Response performance monitoring (6)	Prahalad *et al.,* 2002 Jaworski and Kohli, 1993 Ekman and Angwin, 2007 Jaworski and Kohli, 1993 Koppius and van de Laak, 2008
Learning capabilities	- Internal declarative Memory (6) - Internal procedural Memory (6) - Internal Information Dissemination (8) - External Information Dissemination (6) - Internal learning & feedback (5) - Customer learning & feedback (5) - Partnering learning & feedback (5)	Tippins and Sohi, 2003 Tippins and Sohi, 2003 Tippins and Sohi, 2003/ Jaworski and Kohli, 1993
Sensing IT capabilities	- Internal Data acquisition IT (7) - Customer Data acquisition IT (7) - Partnering Data acquisition IT (7) - Data Assimilation IT (5)	Rowsell-Jones, 2005
Responding IT capabilities	- Internal Response design IT (5) - Customer response design IT (3) - Partnering response design IT (3)	Prahalad *et al.*, 2002 Sambamurthy *et al.*, 2003

Constructs	**Sub-constructs and variables (with number of items)**	**Literature**
	- Internal decision-making IT (5) - Internal response implementation IT (7) - Customer response implementation IT (4) - Partnering response implementation IT (4) - Quick-connect IT (5) - Response performance monitoring IT (6)	Ekman and Angwin, 2007 Jaworski and Kohli, 1993 Koppius and van de Laak, 2008
Learning IT capabilities	- Internal declarative Memory IT (5) - Internal procedural Memory IT (6) - Internal Information Transparency (8) - External Information Transparency (7) - Internal learning & feedback IT (4) - Customer learning & feedback IT (4) - Partnering learning & feedback IT (4)	Tippins and Sohi, 2003 Tippins and Sohi, 2003 Byrd and Turner, 2000 Ekman and Angwin, 2007
Business Agility Performance	Response Time (*) Response Ease (cost) (*) Response Range (scope) (*) Response Quality (*)	Dove, 2001

(*) based on perception of the researcher. No detailed items were used for these variables.

Appendix C: Agility measurement instrument cross case analysis

Table Appendix-C.1 –Cross case analysis on business agility dimensions (based on the agility measurement instrument)

Constructs	case 1 Resource deployment	case 2 MTS	case 3 Water management	case 4 BCRS
Business agility dimensions	**medium**	**high**	**high**	**high**
Sensing	**medium**	**high**	**high**	**high**
1) Internal data acquisition	medium	medium	medium	high
2) Customer data acquisition	medium	high	high	high
3) Partnering data acquisition	low	medium	high	medium
4) Sense-making	medium	high	high	high
Responding	**medium**	**high**	**medium**	**medium**
5) Internal response design	high	high	high	high
6) Customer response design	low	high	high	high
7) Partnering response design	low	low	high	low
8) Internal decision-making	medium	high	high	high
9) Internal response implementation	medium	high	high	high
10) Customer response implementation	low	high	low	low
11) Partnering response implementation	medium	medium	medium	medium
12) Quick-Connect with partners	low	low	low	low
13) Response Performance Monitoring	medium	high	medium	medium
Learning	**medium**	**high**	**high**	**high**
14) Internal declarative memory	medium	high	high	high
15) Internal procedural memory	medium	high	low	high
16) Internal information dissemination	high	high	high	high
17) External information dissemination	low	low	high	low
18) Internal learning & feedback	high	high	high	high
19) Customer learning & feedback	high	medium	high	medium
20) Partnering learning & feedback	high	medium	high	medium

Table Appendix-C.2 –Cross case analysis on IT capabilities (based on the agility measurement instrument)

	Resource deployment	MTS	Water management	BCRS
IT agility capabilities	**medium**	**high**	**high**	**medium**
Sensing IT capabilities	**medium**	**high**	**high**	**medium**
1) Internal data acquisition IT	high	medium	high	medium
2) Customer data acquisition IT	low	high	high	high
3) Partnering data acquisition IT	medium	medium	high	low
4) Sense-making IT	high	high	high	high
Responding IT capabilities	**medium**	**high**	**high**	**medium**
5) Internal response design IT	medium	high	high	high
6) Customer response design IT	low	high	high	high
7) Partnering response design IT	high	low	high	low
8) Internal decision-making IT	medium	high	high	high
9) Internal response implementation IT	medium	high	high	high
10) Customer response implementation IT	high	high	low	low
11) Partnering response implementation IT	medium	medium	low	low
12) Quick-Connect IT with partners	high	high	high	high
13) Response performance monitoring IT	high	high	medium	medium
Learning IT capabilities	**medium**	**high**	**high**	**medium**
14) Internal declarative memory IT	medium	high	high	high
15) Internal procedural memory IT	medium	high	medium	high
16) Internal information transparency	medium	high	medium	high
17) External information transparency	medium	medium	medium	low
18) Internal learning & feedback IT	low	high	high	high
19) Customer learning & feedback IT	low	low	high	low
20) Partnering learning & feedback IT	high	high	high	low

Table Appendix-C.3 –Cross case analysis on alignment

	case 1 Resource deployment	case 2 MTS	case 3 Jamming & Water management	case 4 BCRS
SRL alignment among business capabilities	**medium**	**high**	**medium**	**medium**
Sensing -->Responding capabilities	medium	high	medium	medium
Learning --> Sensing capabilities	medium	medium	medium	medium
Learning --> Responding capabilities	medium	high	medium	high
SRL alignment among IT capabilities	**medium**	**low**	**low**	**low**
Sensing IT -->Responding IT capabilities	high	medium	low	medium
Learning IT --> Sensing IT capabilities	low	low	low	low
Learning IT --> Responding IT capabilities	low	low	low	low
Business -IT alignment	**medium**	**medium**	**medium**	**medium**
Sensing IT --> Sensing capabilities	medium	medium	medium	medium
Sensing IT --> Responding capabilities	high	medium	low	medium
Responding IT --> Responding capabilities	high	high	high	high
Learning IT --> sensing capabilities	low	medium	medium	low
Learning IT --> responding capabilities	low	medium	medium	low
Learning IT --> learning capabilities	low	high	high	low

Sensing capabilities measurement

		Case 1	**Case 2**	**Case 3**	**Case 4**
Variable 1: Internal data acquisition	Reference(s)	**3.3**	**3.3**	**3.3**	**5.0**
1. In this business unit, we do in-house market research	Kohli *et al*., 1993		y	y	y
2. The organization develops scenario's about possible future developments and ways to react	Volberda, 2004	y			y
3. The organization analyzes and evaluates emerging technologies on a structured basis	new			y	y
4. The organization uses and combines internal data sources to sense changing patterns or developments	new	y	y	y	y
5. The organization registers requests and complaints from employees	Volberda, 2004	y	y		y
6. The organization periodically reviews the likely effect of changes in its business environment (e.g. regulations) on customers	Jaworski & Kohli, 1993	y	y	y	y
Variable 2: Customer data acquisition	Reference(s)	**3.3**	**4.4**	**4.4**	**5.0**
1. We meet with our customers in order to find out what their needs will be in the future.	Kohli *et al*. 1993; Tippins and Sohi, 2003	y	y	y	y
2. The organization uses external data sources and IT from customers to sense changing patterns or developments	new		y		y
3. We ask our customers what they want or need.	Tippins and Sohi, 2003	y	y	y	y
4. We collect information concerning our customers' objectives.	Tippins and Sohi, 2003	y	y	y	y

5. The organization involves their customers as a source of innovative ideas for new products and services	Sambamurthy *et al*, 2003			y	y
6. We collect industry information from our customers by informal means (e.g., over lunch, at trade conventions).	Tippins and Sohi, 2003	y	y	y	y
7. The organization registers requests and complaints from customers	Volberda, 2004	y	y	y	y
8. The organization polls end users at least once a year to assess the quality of its products and services	Jaworski & Kohli, 1993	y	y	y	y
9. The organization systematically measures customer satisfaction	Volberda, 2004		y	y	y
Variable 3: Partnering data acquisition	Reference(s)	**2.5**	**3.1**	**4.4**	**3.1**
1. We meet with our partners in order to find out what their needs will be in the future.	adapted from Tippins and Sohi, 2003		y	y	y
2. The organization screens possible partners	new	y	y	y	y
3. The organization uses external data sources from partners to sense changing patterns or developments	new				
4. The organization involves their partners as a source of innovative ideas for new products and services	Sambamurthy *et al*, 2003			y	
5. We collect industry information from our partners by informal means (e.g., over lunch, at trade conventions).	adapted from Tippins and Sohi, 2003	y	y	y	y
6. The organization registers requests and complaints from partners		y	y	y	y
7. The organization receives feedback from partners (for instance via surveys)		y	y	y	y
8. The organization talks to or surveys those who can influence the end users' purchases (e.g. retailers, distributors)	Jaworski & Kohli, 1993			y	
Variable 4: Sense-making	Reference(s)	**3.1**	**4.4**	**3.8**	**4.4**
1. Data that is gathered is filtered for relevancy	new		y		y
2. Data that is gathered is filtered for timeliness	new	y	y	y	y
3. Data that is gathered is analyzed and filtered for accuracy and content	new		y	y	y
4. The organization systematically interprets and analyzes data that is gathered and generated	new	y	y	y	y
5. The organization develops diverse scenarios	Shoemaker & Day, 2009	y	y	y	y
6. The organization tests multiple hypothesis	Schoemaker & Day, 2009	y	y	y	y
7. The organization uses the wisdom of the crowd	Schoemaker & Day, 2009	y		y	
8. Relationships between events and actions are stored for future usage	Choo (1996)		y		y
Total sensing capability score		**3.1**	**3.9**	**4.0**	**4.4**

Responding capabilities measurement

		Case 1	Case 2	Case 3	Case 4
Variable 1: Internal Response Design agility	Reference(s)	**3.6**	**4.3**	**4.3**	**5.0**
1. Employees within the organization can experiment with new products, services or processes	Prahalad *et al*, 2002			y	y
2. Employees within the organization can simulate new products, services or processes		y		y	y
3. Employees can test a response (to an event) before actually implementing it		y	y	y	y
4. Several departments get together periodically to plan a response to changes taking place in our business environment	Jaworski & Kohli, 1993	y	y	y	y
5. The organization periodically reviews its product development efforts to ensure that they are in line with what customers want.	Jaworski & Kohli, 1993	y	y	y	y
6. The business plans are strongly driven by market research	Jaworski & Kohli, 1993	y	y	y	y
7. There are procedures and tools in place to diagnose events and generate possible responses	new	y	y		y
Variable 2: Customer Response Design agility	Reference(s)	**2.5**	**3.8**	**3.8**	**3.8**
1. Customers can experiment with new products, services or processes	Prahalad *et al*, 2002	y	y	y	y
2. The organization involves their customers directly in product design & testing	van Hoek *et al*, 2001; Sambamurthy *et al*, 2003		y	y	y
3. Customers can reconfigure products or services themselves	new	y	y	y	y
4. Customers have procedures and tools to diagnose events and generate possible responses	new				
Variable 3: Partner Response Design agility	Reference(s)	**2.5**	**2.5**	**3.8**	**2.5**
1. Partners can experiment with new products, services or processes	Prahalad *et al*, 2002			y	
2. The organization involves its partners directly in product design & testing	van Hoek *et al*, 2001; Sambamurthy *et al*, 2003	y	y	y	y
3. Partners can reconfigure products or services themselves	new				
4. Partners have procedures and tools in place to diagnose events and generate possible responses	new	y	y	Y	y
Variable 4: Internal decision-making agility	Reference(s)	**3**	**4**	**4**	**4**
1. Managers have supporting tools for their decision-making process	Ekman & Angwin, 2007	y	y	y	y
2. The organization is delayered	Ekman & Angwin, 2007		y	y	y

3. Management decision-making is decentralized	Ekman & Angwin, 2007				
4. There is a high speed of (operational) decision-making	Ekman & Angwin, 2007	y	y	y	y
5. The organization employs multi-functional teams in solving certain problems	Ekman & Angwin, 2007	y	y	y	y
Variable 3: Internal response implementation agility	Reference(s)	**2.9**	**3.6**	**3.6**	**3.6**
1. The activities of the different departments in this business unit are well coordinated	Jaworski & Kohli, 1993	y	y	y	y
2. The organization is quick to respond to significant changes in competitors' pricing structures	Jaworski & Kohli, 1993	y	y	y	y
3. If the organization finds out that customers are unhappy with the quality of the service, corrective actions are taken immediately	Jaworski & Kohli, 1993	y	y	y	y
4. When customers would like modifications of products or services, the departments involved make concerted effort to do so	Jaworski & Kohli, 1993	y	y	y	y
5. The business processes carried out in the organization can be updated quickly, when the need arises	Goldman *et al.* , 1995				
6. The employees and workers of the organization are adaptable and multi-skilled	Ekman & Angwin, 2007		y	y	y
7. The organization can ***quickly*** develop new capabilities					
Variable 4: Customer response implementation agility	Reference(s)	**2.5**	**3.8**	**2.5**	**2.5**
1. The organization involves its customers directly in service delivery	van Hoek *et al*, 2001; Sambamurthy *et al*, 2003	y	y	y	y
2. The organization can mobilize its customers quickly and easily	new	y	y	y	y
3. Customers can monitor progress and status of the response	new		y		
4. Customers can reconfigure the delivery process themselves	new				
Variable 5: Partnering response implementation agility	Reference(s)	**3.0**	**3.0**	**3.0**	**3.0**
1. The organization involves its partners directly in service delivery		y	y	y	y
2. The organization can mobilize its partners quickly and easily		y	y	y	y
3. Partners can monitor progress and status of the response		y	y	y	y
4. Partners can reconfigure the delivery process themselves					
5. The business processes carried out by the partner can be updated quickly, when the need arises	Goldman *et al.* , 1995				
Variable 6: Quick-Connect with partners	Reference(s)	**2**	**2**	**2**	**2**
1. The organization can modify or extend its enterprise network to 3rd parties as needed to access assets, competences or knowledge (to respond to unforeseen	Prahalad *et al.*, 2002; Sambamurthy *et*	y	y	y	y

circumstances)	*al*., 2003				
2. The organization can quickly establish inter-organizational relationships	Koppius & v.d Laak, 2008				
3. The organization can quickly abandon inter-organizational relationships	Koppius & v.d Laak, 2008	y	y	y	y
4. Costs for switching from one partner to another are relatively low	Koppius & v.d Laak, 2008				
5. Newly established relationships are quickly able to handle complexity	Koppius & v.d Laak, 2008				
Variable 7: Response performance monitoring	Reference(s)	**4.2**	**4.2**	**3.3**	**4.2**
1. The organization systematically measures customer satisfaction	new	y	y	y	y
2. The organization systematically measures performance of the operational process		y	y	y	y
3. The organization systematically measures performance of its partners		y	y	y	y
4. The organization receives an alert in case there are deviations in the process or passing of threshold values	Conner, 2000	y	y		y
5. The organization monitors important organizational performance variables	Templeton *et al*, 2002	y	y	y	y
6. The organization has continuous insight in the impact of a specific response on business performance					
Total responding capability score		**3.0**	**3.5**	**3.4**	**3.5**

Learning capabilities measurement

		Case 1	**Case 2**	**Case 3**	**Case 4**
Variable 1: Internal Declarative memory	Reference(s)	**3.3**	**4.2**	**4.2**	**4.2**
1. We retain information concerning our customers (address details, products and services)	new	y	y	y	y
2. We retain information concerning customer facing events	new	y	y	y	y
3. We retain information concerning past events and the actions (solutions) in relation to our process and/or customers	Choo (1996)		y		y
4. The competitive positions of our customers are known to us	Tippins and Sohi, 2003		y	y	y
5. We retain information concerning our customers' overall business objectives	Tippins and Sohi, 2003	y		y	
6. We retain information concerning our products and services (configurations etc)	new	y	y	y	y
Variable 2: Internal Procedural memory	Reference(s)	**3.3**	**5.0**	**2.5**	**5.0**
1. We have a set procedure for handling routine processes	Tippins and Sohi, 2003	y	y	y	y
2. We have learned from past experience how best to deal with customer problems	Tippins and Sohi, 2003	y	y		y
3. We have standard procedures that we follow in	Tippins and Sohi,	y	y	y	y

order to determine the needs of our customers.	2003				
4. We have a standard procedure for effectively dealing with customer complaints.	Tippins and Sohi, 2003		y	y	y
5. The organization can derive inferences from past events (such as process exceptions, patterns of demand shifts, effects of different company responses)	Gosain *et al*., 2004	y	y		y
6. We have guidelines for responding to non-standard exceptions and disruptions	new		y		y
Variable 3: Internal information dissemination	Reference(s)	**4.4**	**5.0**	**5.0**	**5.0**
1. Employees at various levels in the organization have the tools to quickly communicate with each other	Ekman & Angwin, 2007	y	y	y	y
2. Within our firm, information about our customers is easily accessible to those who need it most.	Tippins and Sohi, 2003	y	y	y	y
3. Representatives from different departments within our firm meet regularly to discuss market trends and developments and customers' needs.	Tippins and Sohi, 2003	y	y	y	y
4. When one department obtains important information about our customers, it is circulated to other departments.	Tippins and Sohi, 2003	y	y	y	y
5. Data on customer satisfaction are disseminated at all levels in this business unit on a regular basis.	Jaworski & Kohli, 1993	y	y	y	y
6. We have informal means (lunches, activities) for sharing customer or market related information		y	y	y	y
7. Marketing personnel in our business unit spend time discussing customers' future needs with other functional departments	Jaworski & Kohli, 1993	y	y	y	y
8. Our business unit circulates documents (e.g. reports, newsletters) that provide information on our customers	Jaworski & Kohli, 1993		y	y	y
Variable 4: External information dissemination	Reference(s)	**1.7**	**2.5**	**4.2**	**1.7**
1. Employees at various levels in the organization have the tools to quickly communicate with external partners	Ekman & Angwin, 2007	y	y	y	y
2. Information about our customers is easily accessible to partners who need it	Tippins and Sohi, 2003				
3. When one department obtains important information about our customers, it is circulated to external partners	Tippins and Sohi, 2003			y	
4. Data on customer satisfaction are disseminated to external partners on a regular basis.	Jaworski & Kohli, 1993			y	
5. We have informal means (lunches, activities) for sharing customer or market related information with partners		y	y	y	y
6. External partners have access to declarative and procedural memory of our organization	new		y	y	
Variable 5: Internal learning	Reference(s)	**4.0**	**5.0**	**5.0**	**5.0**
1. Employees are facilitated to share (tacit) knowledge among each other		y		y	y
2. Employees can actively add information to the declarative and procedural memory of our organization		y	y	y	y
3. The organization receives feedback from its employees (for instance via		y	y	y	y

surveys)					
4. Employees feedback on the organization's product, service or delivery process is embedded in the process		y	y	y	y
5. Employees regularly come together to evaluate and improve processes		y	y	y	y
Variable 6: Customer learning	Reference(s)	**4.0**	**3.0**	**4.0**	**3.0**
1. Representatives from different departments within our firm meet regularly with customers to discuss market trends and developments and customers' needs.	Tippins and Sohi, 2003	y	y	y	y
2. Customer can actively add information to the declarative and procedural memory of our organization	new				
3.. Customers are facilitated to share information and experience among each other	new	y		y	
4. Customer feedback on the organization's product, service or delivery process is embedded in the process	new	y	y	y	y
5. The organization regularly comes together with customers to evaluate and improve processes	new	y	y	y	y
Variable 7: Partnering learning	Reference(s)	**4.0**	**3.0**	**5.0**	**3.0**
1. Representatives from different departments within our firm meet regularly with partners to discuss market trends and developments and customers' needs.	Tippins and Sohi, 2003	y	y	y	y
2. External partners can actively add information to the declarative and procedural memory of our organization	new	y		y	
3. External partners are facilitated to share information and experience among each other	new			y	
4. Partner feedback on the organization's product, service or delivery process is embedded in the process	new	y	y	y	y
5. The organization regularly comes together with partners to evaluate and improve processes	new	y	y	y	y
Total learning capability score		**3.5**	**4.0**	**4.3**	**3.9**

Sensing IT capabilities measurement

		Case 1	**Case 2**	**Case 3**	**Case 4**
Variable 1: Internal data acquisition IT	Reference(s)	**4.2**	**3.3**	**4.2**	**3.3**
1. The organization has IS/IT that analyzes and evaluates emerging technologies on a structured basis	new			y	
2. IT of the organization provide the organization's senior executive(s) with externally and internally sourced market insight information	Rowsell-Jones, 2005	y	y	y	y
3. Data from day-to-day operational processes IT provide employees with rapidly identifying trends and issue	Rowsell-Jones, 2005	y	y		
4. The organization has IS/IT to develop scenarios about possible future developments and ways to react	adapted from Volberda, 2004	y		y	y
5. The IT/IS of the organization enables registering requests and complaints from employees		y	y	y	y
6. The IT/IS of the organization enables the organization to systematically		y	y	y	y

measure employee satisfaction					
Variable 2: Customer data acquisition IT	Reference(s)	**2.1**	**3.6**	**3.6**	**3.6**
1. The organization has IS/IT to involve its customers as a source of innovative ideas for new products and services					y
2. The organization uses external data sources and IT from customers to sense changing patterns or developments	new		y	y	y
3. IT of customers provide the organization market insight information					
4. The organization has IT to collect information about customers wants, needs or experiences		y	y	y	y
5. The organization has IT to systematically measure customer satisfaction		y	y	y	y
6. The IT/IS of the organization registers requests and complaints from customers		y		y	
7. The organization has IT/IS to poll end users at least once a year to assess the quality of its products and services	Jaworski & Kohli, 1993	y	y	y	y
Variable 3: Partnering data acquisition IT	Reference(s)	**2.9**	**2.9**	**5.0**	**2.1**
1. IT/IS of the organization helps the organization in gathering information about possible partners locally or internationally	Ekman & Angwin, 2007	y	y	y	
2. IT of partners provide the organization market insight information				y	
3. The organization has IT to involve its partners as a source of innovative ideas for new products and services					y
4. The organization has IT to collect information about partners' wants, needs or experiences					y
5. The IS of the organization enables the organization to systematically measure partner satisfaction		y	y	y	y
6. The IS of the organization registers requests and complaints from partners		y	y	y	y
7. Partners regularly provide feedback via IT (for instance via web-surveys)		y	y	y	y
Variable 4: Sense-Making IT	Reference(s)	**3.8**	**4.4**	**4.4**	**4.4**
1. Data that is gathered is filtered via IT for relevancy	new		y		y
2. Data that is gathered is filtered via IT for timeliness	new	y	y	y	y
3. Data that is gathered is filtered via IT for accuracy and content	new		y	y	y
4. The organization has IS/IT to systematically interpret and analyze data that is gathered and generated	new	y	y	y	y
5. The organization has IT/IT that help identify patterns within and extract knowledge from data sources (e.g. data warehouses, data mining, OLAP, and other reporting tools)	Overby *et al.*, 2006	y	y	y	y
6. The organization has IS/IT to develop diverse scenarios	Schoemaker & Day, 2009	y	y	y	y

7. The organization has IS/IT to tests multiple hypothesis	Schoemaker & Day, 2009	y	y	y	y
8. The organization uses IS/IT to exploit the wisdom of the crowd	Schoemaker & Day, 2009	y		y	
Total sensing IT capability score		**3.2**	**3.6**	**4.3**	**3.4**

Responding IT capabilities measurement

		Case 1	**Case 2**	**Case 3**	**Case 4**
Variable 1: Internal Response design IT	Reference(s)	**3.0**	**4.0**	**4.0**	**5.0**
1. End users have IS/IT tools to create their own applications		y	y	y	y
2. Employees within the organization have IS/IT to experiment with new products, services or processes	Prahalad *et al* ,2002			y	y
3. Employees within the organization have IS/IT to simulate new products, services or processes		y		y	y
4. Employees have IS/IT to test a response (to an event) before actually implementing it		y	y	y	y
5. The IT/IS of the organization enables to diagnose events and generate possible responses		y	y	y	
Variable 2: Customer Response Design IT	Reference(s)	**2.5**	**3.8**	**3.8**	**3.8**
1. The IT/IS of the organization enables its customers to experiment with new products or services	Prahalad *et al*, 2002	y	y	y	y
2. The organization has IT to involve its customers directly in product design & testing	van Hoek *et al*, 2001; Sambamurthy *et al*, 2003		y	y	y
3. Customers can reconfigure products or services themselves via IT	new	y	y	y	y
4. Customers have IT to diagnose events and generate possible responses	new				
Variable 3: Partner Response Design IT	Reference(s)	**3.8**	**2.5**	**3.8**	**2.5**
1. The IT/IS of the organization enables its partners to experiment with new products or services	Prahalad *et al*, 2002	y		y	
2. The organization has IT to involve its partners directly in product design & testing	van Hoek *et al*, 2001; Sambamurthy *et al*, 2003		y	y	y
3. Partners can reconfigure products or services themselves via IT	new	y			
4. Partners have IT in place to diagnose events and generate possible responses	new	y	y	Y	y
Variable 4: Internal decision-making IT	Reference(s)	**3**	**4**	**4**	**4**
1. The IT of the organization provide decision support in supporting the decision-making process	Ekman & Angwin, 2007	y	y	y	y

2. The IT in the organization enable the organization to be delayered	Ekman & Angwin, 2007		y	y	y
3. The IT in the organization enable decentralisation in management decision-making	Ekman & Angwin, 2007				
4. The IT in the organization contribute to the speed of decision-making	Ekman & Angwin, 2007	y	y	y	y
5. IT in the organization support multi functional teams in solving certain problems	Ekman & Angwin, 2007	y	y	y	y
Variable 5: Internal response implementation IT	Reference(s)	**2.9**	**3.6**	**4.3**	**3.6**
1. When customers would like modifications of products or services, the IT enable departments involved to do so	Jaworski & Kohli, 1993		y	y	y
2. The IT enable a quick response to significant changes in competitors' pricing structures	Jaworski & Kohli, 1993	y	y	y	y
3. The organization has IT to quickly develop new capabilities				y	
4. The IT of our organization enable business processes to be changed quickly, when the need arises	Ekman & Angwin, 2007				
5. The IT of our organization supports group collaboration and discussion		y	y	y	y
6. The IT enable the organization to measure the level adaptiveness and skill levels of its employees and workers	Ekman & Angwin, 2007	y	y	y	y
7. IT of the organization support process analysis and feedback		y	y	y	y
Variable 6: Customer response implementation IT	Reference(s)	**3.8**	**3.8**	**2.5**	**2.5**
1. The IT of the organization enables the organization to reach its target customers.		y	y	y	y
2. Customers can monitor progress and status of the response with IT		y	y		
3. Customers can reconfigure the delivery process themselves with IT					
4. The IT of the organization enable the organization to mobilize its customers quickly and easily		y	y	y	y
Variable 7: Partnering response implementation IT		**3.0**	**3.0**	**2.0**	**2.0**
1. The IT of the organization enables the organization to reach its target partners		y	y	y	y
2. Partners can monitor progress and status of the response with IT		y	y		
3. Partners can reconfigure the delivery process themselves with IT					
4. The IT of the organization enable the organization to mobilize its partners quickly and easily		y	y	y	y
5. The IT of the partner enables business processes to be changed quickly, when the need arises	Ekman & Angwin, 2007				
Variable 8: Quick-Connect IT with partners	Reference(s)	**4**	**4**	**4**	**4**
1. The organization's systems are sufficiently flexible to incorporate electronic links to external parties					

2. IT in the organization has resulted in the organization to easily collaborate with foreign/distant partners	Ekman & Angwin, 2007	y	y	y	y
3. IT of the organization enable quickly establishing inter-organizational relationships	adapted from Koppius & v.d Laak, 2008	y	y	y	y
4. IT of the organization enable quickly abandoning inter-organizational relationships	adapted from Koppius & v.d Laak, 2008	y	y	y	y
5. IS costs for switching from one partner to another are relatively low	adapted from Koppius & v.d Laak, 2008	y	y	y	y
Variable 9: Response performance monitoring IT	Reference(s)	**4.2**	**4.2**	**3.3**	**3.3**
1. The organization has IT tools (such as business intelligence dashboards) to continuously monitor the operational process	new	y	y	y	y
2. The organization has IT tools to monitor performance of its partners		y	y		y
3. The organization has IT tools to monitor customer satisfaction		y	y	y	y
4. IT provides users an alert in case there are deviations in the process or passing of threshold values	Conner, 2000	y	y		y
5. The organization has IT to systematically measure key performance indicators		y	y	y	y
6. IT provides the organization continuous insight in the impact of a specific response on business performance					
Total responding IT capability score		**3.3**	**3.7**	**3.6**	**3.4**

Learning IT capabilities measurement

		Case 1	**Case 2**	**Case 3**	**Case 4**
Variable 1: Internal Declarative memory IT	Reference(s)	**3**	**4**	**4**	**4**
1. We retain information in IT concerning our customers' overall business objectives	Tippins and Sohi, 2003			y	
2. We retain information in IT concerning our customers (address details, contracts etc)		y	y	y	y
3. We retain information in IT concerning customer facing events		y	y	y	y
4. We retain information in IT concerning past events and the actions (solutions) in relation to our process and/or customers		y		y	
5. We retain information in IT concerning our products and services (configurations etc)		y	y	y	y
Variable 2: Internal Procedural memory IT	Reference(s)	**3.3**	**5.0**	**3.3**	**5.0**
1. We retain information in IT concerning procedures for handling routine processes	Tippins and Sohi, 2003	y	y	y	y
2. Past experience how best to deal with customer problems are stored in our IT	Tippins and Sohi, 2003	y	y		y
3. IT are used to store standard procedures that we	Tippins and Sohi,	y	y	y	y

follow in order to determine the needs of our customers.	2003				
4. Standard procedures for effectively dealing with customer complaints are embedded in our IT	Tippins and Sohi, 2003		y	y	y
5. IT of the organization support deriving inferences from past events (such as process exceptions, patterns of demand shifts, effects of different company responses)	Gosain *et al.*, 2004	y	y	y	y
6. We retain information in IT concerning non-standard exceptions and disruptions and guidelines for responding	new		y		y
Variable 3: Internal Information transparency	Reference(s)	**3.1**	**3.8**	**3.1**	**3.8**
1. IT in the organization facilitate quick communication among its employees at various levels in the organization	Ekman & Angwin, 2007	y	y	y	y
2. The information generated by the organization's IT is easily accessible to all employees	Ekman & Angwin, 2007				
3. IT support sharing of information seamlessly across the organization, regardless of the location		y	y	y	y
4. A common view of the organization's customer is available to everyone in the organization.	Byrd & Turner, 2000				
5. Data captured in one part of the organization is immediately available to everyone in the organization	Byrd & Turner, 2000	y	y	y	y
6. Mobile Users have ready access to the same data used at desktops	Byrd & Turner, 2000	y	y	y	y
7. The information generated by the organization's IT are distributed to all employees in the organization.	Ekman & Angwin, 2007	y	y	y	y
8. The information generated by the organization's IT is always current	Ekman & Angwin, 2007		y		y
Variable 4: External Information transparency	Reference(s)	**2.9**	**2.9**	**2.9**	**2.1**
1. IT in the organization facilitates quick communication with external partners	Ekman & Angwin, 2007	y	y	y	y
2. The information generated by the organization's IT is easily accessible to external partners	Ekman & Angwin, 2007	y	y	y	y
3. IT supports sharing of information, regardless of the location with external partners			y		y
4. A common view of the organization's customer is available to external partners	Byrd & Turner, 2000				
5. Data captured in one part of the organization is immediately available to external partners	Byrd & Turner, 2000				
6. External partners have access to declarative and procedural memory IT of our organization		y			
7. The information generated by the organization's IT is easily accessible to external customers	Ekman & Angwin, 2007	y	y	y	y
Variable 5: Internal learning IT	Reference(s)	**2.5**	**3.8**	**3.8**	**3.8**
1. The IT of the organization enables employees to share (tacit) knowledge among each other	new				
2. Employees can actively add information to the declarative and procedural memory IT of our organization	new	y	y	y	y
3. The IT of the organization enables the organization to receive feedback from its employees (for	new	y	y	y	y

instance via surveys)					
4. Employees feedback on the organization's product, service or delivery process is embedded via IT in the process	new		y	y	y
Variable 5: Customer learning IT	Reference(s)	**2.5**	**2.5**	**5.0**	**2.5**
1. Customer have IST to actively add information to the declarative and procedural memory IT of our organization	new			y	
2. Customers are facilitated via IT to share information among each other	new			y	
3. Customer feedback on the organization's product, service or delivery process is embedded via IT in the process	new	y	y	y	y
4. The IT of the organization enables customers to evaluate and improve processes	new	y	y	y	y
Variable 6: Partnering learning IT	Reference(s)	**3.8**	**3.8**	**5.0**	**1.3**
1. External partners have IT to actively add information to the declarative and procedural memory IT of our organization	new	y	y	y	
2. External partners are facilitated via IT to share information among each other	new			y	
3. Partner feedback on the organization's product, service or delivery process is embedded via IT in the process	new	y	y	y	
4. The IT of the organization enables partners to evaluate and improve processes	new	y	y	y	y
Total learning IT capability score		**3.0**	**3.7**	**3.7**	**3.3**

Table Appendix-C.4 – Agility measurement questions and scores

Appendix D: Case study database – list of interviews

Table Appendix-D.1 – Case study database - list of interviews

Interview ID	Group	Business Unit	Function	Date
I-1	IBM Netherlands		University Contact Manager	23-9-2008
I-2	Global Technology Services		Consulting partner	05-11-2008
I-3	Global Technology Services	Resource management	Resource management leader	13-11-2008
I-4	Global Technology Services	Maintenance & Technology Services (MTS)	Manager CSM-Community MTS Benelux	30-01-2009
I5	Global Business Services	IBM Global Centre of Excellence for Water Management	Business Development Executive Climate Change	11-02-2009
I-6	Global Business Services	IBM Global Centre of Excellence for Water Management	IT architect water management	11-02-2009
I-7	Global Technology Services	Maintenance & Technology Services (MTS)	MTS Region manager North West	23-2-2009
I-8	Global Technology Services	Business Continuity & Resiliency Services (BCRS)	Business Unit manager	5-3-2009
I-9	Global Business Services	Resource management	Resource management leader	09-03-2009
I-10	Global Technology Services	Business Continuity & Resiliency Services (BCRS)	Technical Solution Manager	12-03-2009
I-11	Sales and Distribution	Resource management	Resource management leader	16-03-2009
I-12	Global Technology Services	Strategy, Process & Innovation	Manager Strategy, Process & Innovation	15-6-2009

Appendix E: Case study database – list of documents

Table Appendix-E.1 – Case study database - list of documents

Document ID	Reference	Type of Document
D-1	IBM (2005) Enterprise on Demand Transformation	Presentation
D-2	Luby, R.E. (2005) IBM's On-Demand Transformation: Building A Globally-Integrated Company with a Synchronized Supply Chain	Presentation
D-3	http://en.wikipedia.org/wiki/IBM	Wikipedia (web page)
D-4	Walker (2007) IBM business transformation enabled by service-oriented architecture, IBM Systems Journal (46,4): 651-667 ; Accessed online: http://www.research.ibm.com/journal/sj/464/walker.html	Online article
D-5a	IBM (2007) Annual report	Document
D-5b	IBM (2008) Annual report	Document
D-6	DiCarlo, L. (2002) How Lou Gerstner Got IBM To Dance Accessed online: http://www.forbes.com/2002/11/11/cx_ld_1112gerstner.html	Book review (web page)
D-7	Mary Helander, Rick Lawrence, Yan Liu, Claudia Perlich, Chandan Reddy, Saharon Rosset (2007) Looking for Great Ideas: Analyzing the Innovation Jam, *KDD'07,* August 12 – 15, 2007, San Jose, California, USA.	Conference article
D-8	IBM Global Technology Services (2008) Business continuity and resiliency services from IBM *Helping business stay in business - whitepaper*	Whitepaper
D-9	IBM Global Services (2008) MTS Benelux Service Guide - Processes and responsibilities related to your Service Agreement	Internal Document
D-10	IBM (2009) Dynamic Infrastructure- Helping Build a Smarter Planet	Whitepaper
D-11	IBM business Consulting Services (2003) It's time to flex – Create the organizational and cultural agility to do business on demand	Whitepaper
D-12	IBM (2006) IBM Transformation: building An Innovation Company for the 21st Century	Presentation
D-13	IBM (2006) Transforming to a Globally Integrated Enterprise	Presentation
D-14	Robbins (2007) The Evolution of Services Science at IBM Business Consulting, Case Study	Case Study
D-15	IBM (2007) – IBM Resource Management	Presentation
D-16	Derby, S. (2004) Managing Talent; the IBM story	Presentation
D-17	Samuel J. Palmisano, S.J. (2004) Speech 2004 IBM Annual Meeting of Stockholders, Providence, Rhode Island, April 27, 2004 Accessed online: http://www.ibm.com/ibm/sjp/04-27-2004.html	Web-Page

Appendix F: Case study protocol

Table Appendix-F.1 – Case study protocol

Step	Activities
1	Introduction by company contact person
2	Informing interviewees with a short presentation, background on the research and the research procedure
3	Round one interviews: 1) conduct semi structured interviews – based on semi structured questionnaire - which are recorded on tape 2) work out interview transcript 3) send transcript to interviewee to correct for mistakes and complement if needed 4) triangulation by doing more interviews within the same case study (context) and conducting interviews with managers and non-managers
4	Interim presentation results to company contact person, validate initial results
5	Round 2: complementary interviews and follow up questions via telephone
6	Feedback final results to interviewees
7	Workshop to discuss and validate results

Appendix G: Cross case analysis IBM cases on IT

Table Appendix-G.1 – Cross case analysis IBM cases on IT

Information Systems and Technologies	Characteristics	Case 1 Resource deployment	Case 2 MTS	Case 3 Jamming and Water Management	Case 4 BCRS
Data acquisition IT					
Customer feedback applications	Corporate	X	X	X	X
Jamming	Corporate			X	
Sense-Making IT					
Text filtering software	Corporate			X	
Response Design IT					
TAP	Corporate			X	
Response Implementation IT					
RCMS (workflow system for calls)	Local		X		
SameTime (chat)	Corporate	X	X	X	X
Response Monitoring IT					
CLAIM (Time writing)	Corporate	X	X	X	X
SAP (contracts, finance, reporting)	Corporate, ERP	X	X	X	X
Prospects (Siebel)	Corporate, ERP	X	X	X	X
PBC application	Corporate	X	X	X	X
IDP application	Corporate	X	X	X	X
Organizational memory IT					
Customer Account management	Corporate	X	X	X	X
Demand Capture	Corporate	X	X		X
Professional Marketplace (PMP)	Corporate	X	X		X
Knowledge DEAL	Corporate	X	X	X	X
BCRS database (Lotus)	Local				X
Information Warehouse	Local		X		
Spare parts database	Corporate		X		X
Team rooms	Corporate	X	X	X	X
Learning & feedback IT					
Customer Trailer Calls	Corporate		X		X
Set-Met database	Local		X		

Appendix H: Cross case analysis relationship sensing-responding-learning with business agility performance

Table Appendix-H.1 – Cross-case analysis of the relationship between sensing, responding and learning and business agility performance

	Construct	Business agility performance			
		Response Time	Response Ease (costs)	Response Range	Response Quality
Case 1	Sensing capabilities	Reduce time for new hires		Adjust range of available skills to adapt to opportunities in pipeline	
Case 1	Responding capabilities	Reduce time for matching	Increase efficiency of matching process, increase efficiency of usage of workforce	Increase range of possible skills via partners	
Case 1	Learning capabilities				Improve data in systems, improve matching of resources to suites
Case 2	Sensing capabilities	Reduce time to initiate a response	Initiate a pro-active response and reduce costs (due to better planning)		
Case 2	Responding capabilities	Reduce time to find a solution and deliver the solution	Reduce costs by remote solutions, improved scheduling and self service concepts	Increase range (multi vendor) by quick-connect to partners	
Case 2	Learning capabilities	Find weak spots in response process and change these to improve timeliness (reduce lead time) (indirect effect)			Improve quality of response process based on customer feedback

	Construct	Business agility performance			
		Response Time	Response Ease (costs)	Response Range	Response Quality
Case 3	Sensing capabilities	Reduce time for development of new ideas (Jamming)	Increase ease of sense making (via text mining software)	Increase range of possible ideas (via crowd sourcing)	Increase quality of possible ideas (tap into wide range of expertise via crowd sourcing)
	Responding capabilities	Reduce time to match opportunities with solutions (due to knowledge databases and social capital)	Improve ease of responding via shared collaborative research lab	Increase range of possible services via partnering and open innovation business model	
	Learning capabilities		Learning from previous jamming events increases ease of Value jam		Improve quality of responses via a shared collaborative research lab
Case 4	Sensing capabilities	Reduce time to initiate a response	Initiate a pro-active response and reduce costs (due to better planning)		
	Responding capabilities	Reduce time to design and deliver a solution by re-usage of explicit knowledge from organizational memory IT	Reduce costs by remote solutions		Increase response quality by re-usage of explicit knowledge from organizational memory IT
	Learning capabilities	Improve response time by learning from testing		Improve response range by learning from testing and evaluations	Improve response quality by learning from testing and customer feedback

List of abbreviations

BCRS	Business Continuity & Resiliency Services
BPM	Business Process Management
BITA	Business-IT Alignment
CAB	Customer Advisory Board
CRM	Customer Relationship Management
CSA	Contractor Sourcing Application
EDI	Electronic Data Interchange
ERP	Enterprise Resource Management
GBS	Global Business Services
GF	Global Financing
GIS	Geographic Information System
GTS	Global Technology Services
IS	Information System
IT	Information Technology
KPI	Key Performance Indicators
MTS	Maintenance & Technology Services
OS	Open seats
PD	Professional Development
PDA	Personnel Digital Assistant
PMP	Professional MarketPlace
POS	Point of Sale
RCMS	Retain Coupled Call Management System
RFID	Radio Frequency Identification
RPO	Recovery Point Objective
RTO	Recovery Rime Objective
S&D	Sales & Distribution

SLA	Service Level Agreements
SOA	Service Oriented Architecture
STG	Systems and Technology Group
TAP	Technology Adoption Program
XML	Extensible Mark-up Language

Definitions and Terminology

Agile Information System	An information system that enables the firm to identify needed changes in the information processing functionalities required to succeed in the new environment, and which lends itself to the quick and efficient implementation of the needed changes (Lui and Piccoli, 2007: 123).
Application Architecture	Blueprint for the individual application systems to be deployed, their interactions, and their relationships to the core business processes of the organization (Open Group).
Bonding social capital	Internal ties, shared purpose and internal cohesiveness of a group (Newell *et al*., 2004).
Bridging social capital	The (informal) relationships among people (Newell *et al*., 2004).
Business Activity Monitoring (BAM)	Real-time control systems that capture events in real-time from multiple, heterogeneous sources and selectively raise alerts within time-limited windows of opportunity (Chandy and McGoveran, 2004).
Business Agility	The ability of an organization to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events, based on the capabilities to sense, respond and learn. (this thesis).
Business Agility Performance	The performance of an organization in swiftly changing businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events. (this thesis)
Business Architecture	The business system (strategy, governance, organization) and business processes in its environment of suppliers, partners and customers (adapted from Open group and Aerts *et al*., 2004).
Business-IT alignment	The alignment between business and IT and the alignment between the different layers of the enterprise architecture (this thesis).
Business Process Management (BPM)	A plethora of technologies for building applications based on business processes (Palmer, 2003).

Codification	The codifying of tacit knowledge into frameworks, standards and executable activities (Welborn *et al*., 2005).
Codification knowledge management strategy	Knowledge is carefully codified and stored in databases (people-to-documents approach). In this strategy IT is used in the form of electronic document systems that codify, store, disseminate and allow reuse of knowledge (Hansen *et al*., 1999).
Customer agility	The ability to co-opt customers in exploration and exploitation of innovation opportunities as sources of innovation, co-creators of innovation and as users in testing ideas or helping other users learn about the idea. Customer agility describes firms' ability to leverage the voice of the customer for gaining market intelligence and detecting competitive action opportunities. (Sambamurthy *et al*., 2003).
Data acquisition	The ability of firms to actively seek out and gather useable information (adapted from Kohli and Jaworski, 1990).
Dynamic capabilities	The ability to integrate, build, and reconfigure internal and external competences to address rapidly-changing environments (Teece *et al*., 1997).
Enterprise architecture	The organizing logic for core business processes and IT infrastructure reflecting the standardization and integration of a company's operating model (Ross *et al*., 2006).
Explicit knowledge	Formal knowledge that is easy to transmit between individuals and groups (Choo, 1996).
External agility	The ability to change and reconfigure the external parts of the enterprise - partners, suppliers, distributors, and even customers in response to change, unpredictable events and uncertainty in the business environment (Kidd, 2000).
Grid computing	Pooling of resources across multiple information systems and networks and their allocation on demand to provide the quality of service typically associated with a single large mainframe or supercomputer, at a lower price/performance ratio (Boden, 2004).
Heuristic knowledge	The knowledge that arises as individuals engage in their daily routines and improvise in response to particular situations (Orlikowski, 1996).
Information architecture	The structure of an organization's logical and physical data assets and data management resources (Open Group).

Information dissemination	The extent to which the information that is obtained by a firm is shared between its functional units through formal and informal channels (Maltz and Kohli, 1996).
Infrastructure architecture	Generic resource layer consisting of networks, physical infrastructure, operating systems, middleware that will be used to support the deployment of core, mission-critical applications and forms a platform for the construction of the system for the enterprise (adapted from Open group and Aerts *et al*., 2004).
Internal agility	The ability to change and reconfigure the internal parts of the enterprise - strategies, organization, technologies, and even people in response to change, unpredictable events and uncertainty in the business environment (Kidd, 2000).
IT Agility	The ability of Information Technology to support an organization to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events (this thesis).
IT infrastructure Agility	The ability to build a system that can easily be reconfigured, scaled, deconstructed and reconstructed as needed, to adapt to unanticipated changes (Ngo-ye and Ahsan, 2006).
Learning capability	The ability of an organization to explore and acquire new and relevant knowledge, to assimilate data and experience into information and to exploit, use and renew knowledge when required, in order to enhance sensing and responding. (this thesis).
Operational agility	The ability to accomplish speed, accuracy, and cost economy in the exploitation of innovation opportunities (Sambamurthy *et al*., 2003).
Organizational memory	The amount of stored information or experience a firm has about a particular phenomenon (Moorman and Miner, 1997: 103). A distinction can be made between declarative memory (knowledge of facts and events) and procedural memory (knowledge about routines, processes and procedures) (Moorman and Miner, 1998).
Partnering agility	The ability to leverage assets, knowledge, and competences of suppliers, distributors, contract manufacturers and logistics providers in the exploration and exploitation of innovation opportunities. (Sambamurthy *et al*., 2003).

Personalization knowledge management strategy	Knowledge is closely tied to the person who developed it through personal experience. In this strategy (tacit) knowledge is shared mainly through person-to-person contacts and IT is used to facilitate conversations and exchange of tacit knowledge (e.g. people-finder databases) (Hansen *et al.*, 1999).
Radio Frequency Identification (RFID)	Radio Frequency Identification is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders.
Responding capability	The re-active or pro-active adaptation or innovation of capabilities and the implementation of agility capabilities (Dove, 2001)
Response implementation	The ability to reconfigure or adapt business, operations or IT capabilities and respond with new or adapted capabilities (this thesis).
Sense-making	The ability to assimilate data into information (by filtering it for relevancy, timeliness, accuracy and content), interpret the information, analyze the urgency, causes and impact of the event (this thesis).
Sensing capability	The ability of organizations to actively seek out and gather useable data, assimilate this into information (by filtering it for relevancy, timeliness, accuracy and content), interpret and analyze the urgency, causes and impact of the derived information and as such, anticipate or detect opportunities and threats in the business environment (adapted from Kohli and Jaworski, 1990; Dove, 2001).
Service Oriented Architecture (SOA)	Architecture based on services. Services are self-describing, open components that support rapid , low-cost composition of distributed applications. Services provide a distributed computing infrastructure for both intra- and cross enterprise application integration and collaboration (Papazoglou and Georgakopoulus, 2003).
Social capital	The network ties of goodwill, mutual support, shared language, shared norms, social trust, and a sense of mutual obligation that people can derive value from. It is understood as the glue that holds together social aggregates such as networks of personal relationships, communities, regions or even whole nations (Huysman and Wulf, 2004).
SRL alignment	The maturity, balance and relationship between sensing, responding and learning (IT) capabilities (this thesis).

Tacit knowledge	Personal knowledge that is hard to formalize or communicate to others (Choo, 1996).
Quick-connect	The capability to quickly establish an inter-organizational tie that facilitates the exchange of information and transactions, facilitates quickly disconnecting and quickly handling complexity with new business partners (Koppius and van de Laak, 2008).

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Summary

Service organizations have to deal with highly uncertain events, both in the internal and external environment. In the academic literature and in practice there is not much knowledge about how to deal with this uncertainty. This PhD dissertation investigates the role and impact of information technologies (IT) on business agility in service organizations. Business agility is a relatively new term defined as the capability of organizations to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events. Empirical research was carried out via surveys and interviews among managers from 35 organizations in four industries and in three governmental sectors. Four in-depth case studies were carried out within one service organization.

The dissertation has six key findings:

1) In many large service organizations business agility is hampered by a lack of IT agility.

2) Organization and alignment of processes and information systems via the cycle of sensing, responding and learning along with the alignment of business and IT are important conditions for improving business agility performance of service organizations.

3) Standardization of IT capabilities and higher levels of data quality support higher levels of business agility of service organizations.

4) Two knowledge management strategies – codification and personalization -- are identified that can be used to respond to events with different degrees of uncertainty. A codification knowledge management strategy supports the response to events with low levels of uncertainty by exploiting explicit knowledge from organizational memory. A personalization knowledge management strategy drives the response to events with high levels of uncertainty by exploitation of tacit knowledge and social capital.

5) Social capital is an important moderating variable in the relation between IT capabilities and business agility. Social capital can mitigate the lack of IT agility that exists in many service organizations by overcoming information system boundaries and rigidities via human relationships.

6) The combination of sensing, responding and learning capabilities is required to increase all dimensions of business agility performance.

Overall, this research introduces a new approach to analyze and measure business agility. This thesis takes the first steps to develop theoretical knowledge on the conditions under which IT supports higher levels of business agility and business agility performance.

Samenvatting (Summary in Dutch)

Serviceorganisaties worden in toenemende mate geconfronteerd met onzekere gebeurtenissen, zowel in hun interne als externe omgeving. In de academische literatuur en in de praktijk is er weinig kennis hoe om te gaan met deze onzekerheid. In dit proefschrift wordt de rol en invloed van informatie technologie (IT) onderzocht op het reactievermogen van serviceorganisaties. Reactievermogen is een relatief nieuw begrip, wat gedefinieerd is als de capaciteit van organisaties om het bedrijf en de bedrijfsprocessen snel te kunnen veranderen – verdergaand dan het normale niveau van flexibiliteit – om onzekere en onverwachte interne en externe gebeurtenissen met in potentie verstrekkende gevolgen effectief te kunnen managen. In het proefschrift worden drie empirische studies uitgevoerd door middel van vragenlijsten en interviews met managers van 35 organisaties in vier industrieën en drie overheidssectoren (hoofdstuk 4 en 5) en vier diepgaande case studies binnen een serviceorganisatie (hoofdstuk 6).

Deze dissertatie bevat zes hoofdbevindingen:

1) In veel grote serviceorganisaties wordt het reactievermogen belemmerd door een gebrek aan wendbaarheid van informatie technologie.

2) Organiseren en onderling afstemmen van processen en informatiesystemen via de cyclus van waarnemen, reageren en leren en het afstemmen tussen business en IT zijn belangrijke voorwaarden voor de verbetering van het reactievermogen van serviceorganisaties.

3) Standaardisatie van IT en verbetering van data kwaliteit dragen bij aan een verbetering van het reactievermogen van serviceorganisaties.

4) Twee kennismanagement strategieën zijn geïdentificeerd die toegepast kunnen worden als reactie op gebeurtenissen met een verschillende mate van onzekerheid. Een codificatie kennismanagement strategie wordt toegepast als reactie op gebeurtenissen met een lage mate van onzekerheid door middel van de exploitatie van in databases vastgelegde expliciete kennis. Een personalisatie kennismanagement strategie wordt toegepast als reactie op gebeurtenissen met een hoge mate van onzekerheid door middel van de exploitatie van impliciete kennis en het sociaal kapitaal van mensen. De keuze tussen deze twee aanpakken is afhankelijk van de mate waarin kennis gecodificeerd kan worden, de mate waarin werknemers hun kennis willen en kunnen delen en het soort onzekerheden waarop gereageerd moet worden.

5) Het sociaal kapitaal van mensen is een belangrijke variabele die de relatie tussen IT capaciteiten en het reactievermogen beïnvloed. Het kan een alternatief bieden voor het gebrek aan IT wendbaarheid dat in veel serviceorganisaties aanwezig is, door het ondervangen van de grenzen en de starheid van informatiesystemen via menselijke relaties.
6) De combinatie van waarnemen, reageren en leren is vereist om alle dimensies van het reactievermogen (tijd, kosten, kwaliteit en bereik) te verbeteren.

Alles omvattend wordt in dit onderzoek een nieuwe aanpak geïntroduceerd om het reactievermogen te analyseren en te meten. In dit proefschrift worden de eerste stappen gezet in de ontwikkeling van theoretische kennis waarmee de condities kunnen worden verklaard waaronder IT bijdraagt aan een verbeterd reactievermogen van de organisatie.

About the Author

Marcel van Oosterhout was born in Breda, the Netherlands on May 26, 1972. He attended Athenaeum at Thomas Moore College (later renamed Markland College) in Oudenbosch, where he obtained his diploma in 1990. From 1990 to 1996, Marcel studied business administration at the Rotterdam School of Management, Erasmus University, where he obtained his Masters of Science degree in Business Administration. He specialized in information management and logistics management. Based on his Masters thesis Marcel wrote together with Martijn Hoogeweegen an article '*De kosten en baten van EDI in logistieke transport ketens: een case studie in de haven van Rotterdam [in Dutch]*'. This article won the Telematics Student Award 1996. The prize was used to participate in a study trip to Silicon Valley in 1997.

Starting May 1996, Marcel was employed at a consulting unit of Erasmus University. Marcel worked as a consultant and later as a project manager to develop, manage and execute innovative and knowledge-intensive contract research projects.

In 2004 Marcel moved to the Department of Decision & Information Sciences, part of the Rotterdam School of Management, Erasmus University. Here he was employed as project manager/scientific researcher. He continued his work as a project manager and became treasurer for the department and member of the daily board. In 2005 he started to develop his first ideas to conduct PhD research in line with the research projects where he was engaged and his personal research interests.

Marcel has participated in fifty national and international applied research and consulting projects. He has researched for a wide range of organizations, ranging from the European Commission (Martrans, POET, E-Factors, PRIME, BEinGRID, Integrity projects), national government (Ministry of Economic Affairs), international companies (Microsoft, Hewlett Packard, Sogeti, KPN, NS, KLM, TNT, Eneco, Essent) to local governmental organizations (like Rotterdam Port Authority) and various Dutch foundations (Transumo, Connekt, Media Plaza and ECP-EP.NL).

Marcel has (co)authored a number of papers and book chapters and presented his research at several international conferences, such as Business Agility and IT Diffusion IFIP TC 8 WG 8.6 International Working Conference (May 2005, Atlanta, USA), Smart Business Networks Conference (May 2006, Putten, the Netherlands), the 6th Workshop on e-Business WeB (December 2007, Montreal, Quebec, Canada) and Smart Business Networks Conference (May 2008, Bejing, China). His research on IT agility and business agility was published in the European Journal of Information Systems (van Oosterhout, 2006a) and as a book chapter in Desouza (2006). Marcel has reviewed papers for international conferences and journals, such as ECIS, EJIS, Electronic Markets and HICSS. Marcel can be contacted via email (moosterhout@rsm.nl) or via www.moosterhout.nl.

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BUSINESS AGILITY AND INFORMATION TECHNOLOGY IN SERVICE ORGANIZATIONS

Service organizations have to deal with highly uncertain events, both in the internal and external environment. In the academic literature and in practice there is not much knowledge about how to deal with this uncertainty. This PhD dissertation investigates the role and impact of information technologies (IT) on business agility in service organizations. Business agility is a relatively new term, defined as the capability of organizations to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events. Empirical research was carried out via surveys and interviews among managers from 35 organizations in four industries and in three governmental sectors. Four in-depth case studies were carried out within one service organization.

The dissertation has six key findings:

1) In many large service organizations business agility is hampered by a lack of IT agility.
2) Organization and alignment of processes and information systems via the cycle of sensing, responding and learning along with the alignment of business and IT are important conditions for improving business agility performance of service organizations.
3) Standardization of IT capabilities and higher levels of data quality support higher levels of business agility of service organizations.
4) Two knowledge management strategies – codification and personalization – are identified that can be used to respond to events with different degrees of uncertainty.
5) Social capital is an important moderating variable in the relation between IT capabilities and business agility.
6) The combination of sensing, responding and learning capabilities is required to increase all dimensions of business agility performance.

This thesis takes the first steps to develop theoretical knowledge on the conditions under which IT supports higher levels of business agility and business agility performance

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P.O. Box 1738, 3000 DR Rotterdam
The Netherlands

Tel. +31 10 408 11 82
Fax +31 10 408 96 40
E-mail info@erim.eur.nl
Internet www.erim.eur.nl

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