

STRATEGIC FLEXIBILITY AND IT INFRASTRUCTURE INVESTMENTS - EMPIRICAL EVIDENCE IN TWO CASE STUDIES

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Abstract

This paper presents an empirical study to explore how firms invest in their IT infrastructure to support strategic flexibility. It investigates how IT infrastructure capabilities relate to strategic flexibility, how firms build flexibility into their IT investment decisions, and how the firms use IT to support strategic flexibility. Our cases indicate that different types of needed flexibility at the organizational level, ask for different types of IT infrastructure capabilities. In both cases, flexibility is supported by centrally organized management-oriented IT infrastructure capabilities. In the IT investment process, flexibility in the investment decision-making process is implicitly taken into account, whereas IT infrastructure flexibility is explicitly valued for. In both cases, management expects more explorative use of applications supported by IT infrastructure investments to better enhance strategic flexibility than exploitative use does. The implications for further research are discussed.

Keywords: strategic flexibility, IT infrastructure, real options theory, resource based theory, organizational learning

1 INTRODUCTION

The degree in which organizations in a turbulent environment can respond to competing demands while being in control is referred to as strategic flexibility. The business imperative of strategic flexibility is posing requirements on the firm's IT capabilities. Recent research such as Duncan (1995), Byrd and Turner (2001), Weill, Subramani and Broadbent (2002), and Ross (2003) has focused on how to structure the IT infrastructure assets and resources when aiming for IT infrastructure and strategic flexibility.

In this paper, we are interested in exploring the linkages between the flexibility an organization needs and its IT infrastructure investments. Specifically, the purpose of this paper is to explore whether different types of needed flexibility at the organizational level ask for different types of IT infrastructure capabilities, how firms build flexibility into their IT investment decisions, and how the firms use IT to support strategic flexibility. To meet the research objective, we have conducted a literature review leading to a general research framework to guide the explorative case studies. We have tried to take a closer look at the important constructs and the relationships between them. In this paper, we report on the conceptual and empirical study, and present the findings. Using these findings, we present improvements for a more detailed research framework that will guide us in future research.

The paper is structured as follows. In section two, the literature on IT infrastructure and strategic flexibility is reviewed. In section three these findings are put in a conceptual framework that we use in the exploratory case study research. In section four, the research methodology is discussed and we present the case study data. In section five, the cases and their analysis is presented. In section six, we discuss the limitations of our study and present improvements on the model that will be the basis for future research.

2 STRATEGIC FLEXIBILITY AND IT INFRASTRUCTURE

INVESTMENTS

A firm's needed degree of flexibility is dependent on the turbulence of a firm's environment, which is formed by its competitive forces and can be measured in terms of dynamism, complexity and predictability (Volberda 1998). An organisation's flexibility is the degree to which an organization possesses a variety of actual and potential procedures, and the speed at which they can be activated, to increase the control capacity of management and improve the controllability of the organization (Volberda 1998, Byrd and Turner 2000). Confronted by a dynamic, complex, and unpredictable environment, firms need strategic flexibility, which reflects the possession of an advanced repertoire of dynamic capabilities. Strategic flexible firms possess the ability to easily and quickly change key aspects of business strategy, thereby improving their potential for a favourable competitive position (Hitt et al 1998, Volberda 1998). Strategic flexible firms can have a fast response to: (1) changes in aggregate customer demand, (2) customize a product or service to suit an individual customer, (3) new product or service launches by competitors, (4) introduce new pricing schedules in response to changes in competitors' prices, (5) easily expansion in new markets or regions, (6) adopt and apply new technologies to produce faster, better and cheaper products and services, (7) fundamentally renew products, (8) cooperate or easily switch in co-makership, co-design or just-in-time purchasing to avail of lower costs, better quality or improved delivery times.

Strategic flexibility poses requirements on the IT capabilities to provide cost-effective, scalable IT infrastructures that enable the organization to design and implement new business process applications to respond to emerging business opportunities. Weill and Broadbent (1998) define IT infrastructure as the base foundation for building business applications, which is shared throughout the firm as reliable

services (Weill and Broadbent 1998). They have found that firms have to be leading in certain infrastructure capabilities, depending on the type of business initiative a firm wants to implement in their aim for strategic flexibility. These types of business initiatives are characterized by: (1) their position on the value net (supply, internal or demand initiative), (2) the type of exchange (B2B or B2C) and (3) the position on the value net (new market or new product initiative). Although the capabilities of IT infrastructure are one of the most critical issues IT managers are facing, there is still little empirically based research with a focus on IT infrastructure capabilities and the specific organizational flexibility that these capabilities support and how organizations identify and manage these investments when dealing with a turbulent environment. In the next sections we will introduce a conceptual model to address this topic.

3 CONCEPTUAL FRAMEWORK

To help underpin the research on strategic flexibility and IT infrastructure, we draw insight from three theoretical frameworks: the resource based theory, the real option theory, and the theory of organisational learning. Using the resource based theory, one can explain how organizations structure their technological assets and resources to take advantage in a competitive market environment. Options theory suggests how firms can capitalize on their strategic options in a fast and changing business environment (Amran and Kulatilaka, 1999). The theory of organisational learning helps us to explain how firms unite the contending forces of exploration and exploitation in their aim for flexibility. A combination of these three frameworks will provide indepth knowledge on how organizations structure and use their IT infrastructure assets and resources given the uncertainty and irreversibility of their IT infrastructure investments.

3.1 Resource-based theory and IT infrastructure capabilities

Adopting a resource-based view of IT infrastructure, it is argued that a firm's overall effectiveness is determined by the leverage of a firm's investments to create unique IT resources and skills that are firm-specific, rare, and difficult to imitate or substitute (Barney 1991, Clemons 1991, Mata et al. 1995). Grant (1991) distinguishes between resources and capabilities. While resources serve as basic units of analyses, capabilities are repeatable patterns of action in the use of resources to create, produce, or offer value to a market.

Weill, Subramani and Broadbent (2002) identify ten IT infrastructure capability clusters. The clusters comprising the *physical* layer of IT infrastructure capability are: (1) channel management, electronic channels firms need to link to customers and partners, (2) security and risk-management services, which provide protection for the firm's brand, reputation, data, equipment and revenue stream, (3) communication services, through which electronic interactions with customers and partners occurs, (4) data-management services, which provide for management of data assets, (5) application infrastructure services, applications that are standard across the firm and (6) IT facilities management services, which coordinates and spans the physical infrastructure layers and adds value by integrating the five other physical layers. In addition to these clusters that constitute a firm's physical IT infrastructure capabilities, there are several clusters representing *management-oriented* capabilities, among which: (7) IT management services, which coordinate the integrated infrastructure and manage its relationships with the business units, (8) IT architecture and standards services, which comprises the core policies that govern the use of information technology and that determine how future business will be done, (9) IT-education services, which includes training in the use of specific technologies and education for management on IT investment to create business value and (10) the IT Research and Development services, which includes the firm's search for new ways to use IT to create business value. We use this service view, which has been adopted in other IT infrastructure studies (Weill, Subramani and Broadbent 2002), as a representation of IT infrastructure. Resource based theory offers us a lens through which we can examine between the distinguished IT infrastructure capabilities and analyse how these capabilities differ in the extent of organisational flexibility they provide.

3.2 Real options theory and flexibility of IT investments

Resource based theory favours investments that minimize the current level of uncertainty and performance variance (Peffer and Salancik 1978). Real options theory is seen as an alternative to resource based theory in situations involving irreversible decisions under high uncertainty. A real option, by definition, gives the holder the right, but not the obligation to take ownership of an underlying asset at a future point in time.

Option models have been shown to be applicable to making IT investments (e.g., Benaroch and Kauffman 1999, Taudes et al. 2000). Although there are limitations in applying options theory to emerging technology investments, option researchers and innovation scholars agree that real options are useful in understanding the adoption of emerging IT and stress the importance of recognizing that real options analysis is first and foremost a way of thinking about how technology investments can be structured and managed (Jarvenpaa and Tiller 1999, Amran and Kulatilaka 1999, McGrath and McMillan 2000, Fichman 2004).

Since flexibility is synonymous with the creation of real options (Benaroch and Kauffman 1999), an increase of flexibility in the IT infrastructure investment process and result can have a positive influence on the value of IT investments. Promoting flexibility in the investment or systems development decision-making *process* or promoting flexibility in the *result* of the investment (i.e. IT infrastructure flexibility) creates a quantifiable value, and this value exists whether or not an organization actually attempts to quantify it using an options pricing model (Fichman, Keil, and Tiwana 2003). Fichman, Keil, and Tiwana (2003) distinguish between different types of real options that commonly exist in IT investment decision making processes and show how the options create value: (1) stage investments (i.e., projects can be divided into distinct stages), (2) to abandon investment, (3) defer initiation of investment, (4) to create growth opportunities based on an initial investment, (5) to change the scale of investment, and (6) to switch assets created by the investment to another use. We will use these different types of options to analyse the extent of flexibility in the IT infrastructure investment decision-making process. Real options theory offers us a lens through which we can examine how and whether organizations identify, track and actively increase flexibility in the IT infrastructure investment process and result.

3.3 Organizational learning and IT use

Where IT infrastructure investments enable business applications to be implemented, research shows that it is not the nature of technology investments but how these investments are used, that determine the nature of outcomes for firms (Subramani 2004). To explore this consideration, we will use a theory that draws on organizational learning (March 1991). Organisations learn through several capabilities that create knowledge or modify existing knowledge. Specifically, there are two different capabilities for organizational knowledge production that affect how much and what kind of knowledge is produced: exploration and exploitation. Exploration generates new, unsettled knowledge with potentially high but uncertain returns, giving firms preferential advantages in exploiting its options. It captures search, variation, risk taking, experimentation, play, flexibility, discovery and innovation (March 1991). Exploitation generates incremental knowledge with moderate but certain, immediate returns (Schulz 2001) and captures refinement, choice, production, efficiency, implementation and execution (March 1991). In line with this, IT use for exploration refers to the use of technology where the IT investment supports non routine, unstructured tasks to create new capabilities or to devise novel solutions to existing problems, e.g. integrating functions or understanding trends in sales and customer preferences, or create new business opportunities. IT use for exploitation refers to the use of technology where the IT investment supports structured, repetitive tasks (e.g. transaction processing activities) to improve, apply and incrementally refine firm capabilities or improve existing solutions (Subramani 2004). This theory offers a framework to research whether and how the IT use influences strategic flexibility.

3.4 Conceptual framework

A conceptual framework based on the elements described above was developed to guide the field study and the data collection of this study (Yin 1994). The strategic context (A) is defined as the degree of environmental turbulence and is measured in terms of dynamism, complexity and predictability (Volberda 1998). Depending on the strategic context, firms need specific strategic flexibility (B), which is defined using Volberda (1998). The need for specific types of flexibility leads to IT infrastructure resource investment (C), which leads to: (1) different IT infrastructure capabilities (C), which will be categorized using Weill, Subramani, and Broadbent (2002) (see section 3.1), (2) IT flexibility (D), which will be separated in IT flexibility in the IT investment decision-making *process* using Fichmann, Keil and Tiwana (2003) and in IT flexibility in the *result* of the investment (see section 3.2) and (3) IT use, which will be separated in IT use for exploitation and IT use for exploration, using the definition by Subramani (2004) (see section 3.4).

The model in Figure 1 raises the following research questions, which will lead the investigation:

- Depending on the specific flexibility needed, what IT infrastructure capabilities do firms develop and how do these IT infrastructure capabilities support strategic flexibility? And more specifically, how do the distinguished IT infrastructure capabilities differ in the extent of strategic flexibility they provide?
- When aiming for specific types of flexibility, how do firms invest in IT infrastructure flexibility and how do they identify, track and actively increase the extent of flexibility in IT infrastructure investment decision-making process?
- How does IT use support strategic flexibility? And more specifically, if strategic flexibility is needed, does IT use for exploration support organizational flexibility more than IT use for exploitation does?

The framework is shown in Figure 1.

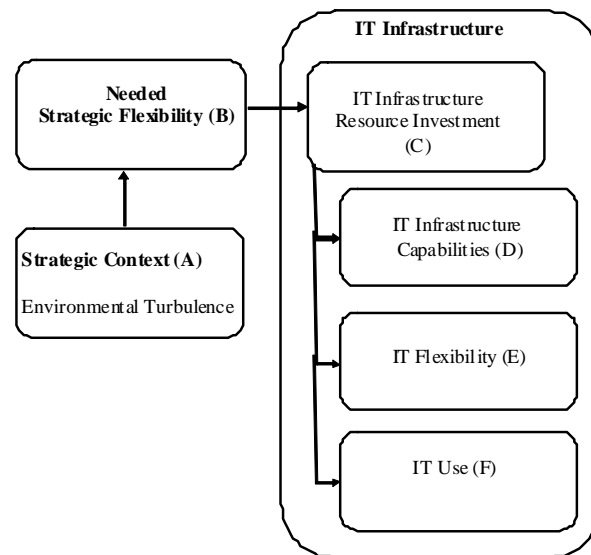


Figure 1: Conceptual model used to guide the case study research

4 FIELD STUDY

4.1 Study design

To further explore the relationships between the strategic context, strategic flexibility, IT infrastructure capabilities, IT flexibility and IT use, we conducted a multiple explorative case study. To explore IT use and the necessary IT capabilities, the logic of qualitative research is preferred in this stage. Also, case studies can allow the level of detail that is necessary to understand how management in different strategic contexts builds flexibility into the investment process. For the purpose of this paper, we selected two firms in different industries and in different strategic contexts. We selected cases with firms where the needed types of flexibility differed. Within these firms we selected IT infrastructure investments that are complex, strategic or innovative.

One firm is a Dutch nationally operating bank, which operates in a complex, dynamic but highly predictable environment. The other firm is a Dutch internationally operating lithography company that is operating in a complex, dynamic, and unpredictable environment.

The cases were studied from May to August 2004, and encompass in-depth semi-structured interviews with the CIO, a business manager, an IT architect and, in a single case, an external IT-supplier. A set of open questions was used to roughly guide the interviews. Archival data based on internal documents, industry publications, and other written material were used. The cases will be described in more detail in the following section.

4.2 The case of the Dutch bank

4.2.1 Strategic context

The Dutch bank is a business unit of a banking and insurance group with approximately 6000 employees. The bank and the other business units of the group operate quite independently from one another. The bank has its own internal IT organisation which employs about 250 people. The bank is one of the five large banks in the Netherlands, and has its focus on the national retail market. The bank's environment can be described as dynamic, complex but predictable.

4.2.2 Needed strategic flexibility

The bank has started a strategic reorientation in 2000, which resulted in a choice for product leadership, by striving for offering innovative products among different channels with a short time to market that can quickly respond to changes in customer preferences and changes in competitors' actions. Strategic flexibility is needed in terms of a fast response to: (1) changes in aggregate customer demand, (2) customizing products or services to suit an individual customer and (3) new product launches by competitors.

4.2.3 IT infrastructure resource investment

In early 2000, the IT department began the process of aligning the information infrastructure with the new corporate strategy by uniting all of its retail distribution channels into a common technical strategy. In 2001, the IT department started with the implementation of a new strategic infrastructure

platform, an IBM WebSphere¹ platform. With this platform, the banks main goal was to invest in laying an internal foundation to meet the strategic objectives.

4.2.4 *IT infrastructure capabilities*

The WebSphere implementation project started as an architecture project since the platform must fulfil an integral part of the future IT Bank architecture at business unit level. The platform provides for channel management capabilities, since it is intended to be the strategic application development platform and to support applications for all different channels and labels (which include the offices, the call-centre, the Internet, intermediaries and electronic applications like cash-machines). By choosing a platform based on open standards, it is expected that future technologies will be added relatively easy. The platform provides for application infrastructure capabilities, since it supports back-office application integration, thereby improving communication between the front-office and back-office systems and making application development cheaper. In the future the reusability of transactions over different front-office channels is expected to lead to reduced maintenance costs and to simplified application management.

Central data management services at business unit level heavily facilitated the platform implementation technically. Easy access to centrally stored client data at business unit level has prevented discussions about adjusting data definitions and data quality issues and has made it relatively easy to implement projects at the demand side, such as implementing Internet-banking, Internet-saving-accounts and i-mode applications.

Strongly developed IT management services in terms of forward strategic planning lead to the IT platform investment in the first place; the business first was reluctant to the implementation. However, the IT management board considered the platform to be an essential investment for fast response in future demand side initiatives. By specifying architecture guidelines for the way IT applications will be used an integrated, the IT architecture and standards capabilities matured.

4.2.5 *IT flexibility*

In general, the bank has a relative advantage in the efficiency and effectiveness of its IT decision-making as opposed to competitors, by its relatively small size and its centrally organized IT department. The IT investment decision cycle for large projects has recently been brought back from a one-year-project-planning-cycle, to a one-year-project-planning-cycle with a revision of the project planning every quarter, thereby allowing to respond faster to opportunities that arise. A special project committee has been installed to prioritise projects and to advise the CIO and the board of directors. The bank allows for small investments in strategic experiments to keep up with competition. IT investment decisions are based on a ROI business case and valued on a diversity of additional criteria, among which the extent to which a project can be deferred. Flexibility is explicitly taken into account in the investment process by looking at scalability, the openness of the solution and the possibilities for reusability.

The decision-making process for the platform investment comprises several stages: (1) an architecture phase of one month, (2) an implementation phase of four-and-a-half months, consisting of the development and implementation of a working applications and the development and implementation of the needed organisational methods and techniques. After this project, the bank's largest 16-bits front office application consisting of 3,000 transactions was rebuilt into new reusable functionality, taking several years to complete.

¹ The following WebSphere products were tested: WS Visual Age for Java, WS Application Server, WS Business Components Composer, WS Bank Business Teller Components. The first three products were finally purchased.

“This application is one of the major justifications for implementing the platform, which every business unit will use either totally or partially,” says the project manager “If we can realize savings by reusing every form of transaction, in fact we will have profited 3,000 times.”

This project, that would have taken approximately 45 man-years to complete, could be completed in approximately 25 man-years due to the platform investment and has been completed in 2004. This project was not explicitly valued in the business case for the platform implementation, but was implicitly taken into account.

4.2.6 *IT use*

The two initially developed applications supported by the new platform comprised two applications that were built to improve and refine existing solutions to support structured, transaction processing activities. The bank scheduled two additional near future projects to importantly renovate the method in which the bank expects to do business with its customers. The platform is thus planned to allow for future explorative use, since it is to support the integration of product innovation and service integration among different channels. One project aims at building an application that supports assisted-investing, by which customers can invest with self-assistance through the web instead of with bank-office support. Another project aims at further developing middle-layer application integration, which helps to create a complete customer profile to enable the new multi-channel applications to provide customers with all account information at once.

The development of new product releases is more complex, which asks for a more multidisciplinary view on software maintenance.

“We have won in flexibility if we want to launch new products among multiple channels. But this gain in flexibility has a downside: on the whole, things have become more complex because of working in multidisciplinary IT and business teams. Also, if we want to launch a product in one channel only, these projects take more time.” Business manager

Although productivity rates are managed strongly, a loss in productivity when implementing new functionality due to learning-time is noticed on the business side and is compensated for by the IT department. On the organizational side, extra time is needed when accommodating requests among channels; business people are obliged to work in cross-channel teams.

4.3 The case of the Dutch lithography firm

4.3.1 *Strategic context*

The global lithography firm operates in the chip technology business with a client base consisting of large high-tech international firms. One of the basic characteristics of the firm is that it finds itself in a highly cyclic market; the global economic cycles are very well sensible and periods with high and low sales rates are swift. Despite this environmental turbulence, the firm is the leading technology provider in its industry. It has approximately 5,000 employees among which are production employees, engineers and machine software-developers. It owns an internal IT department with about 400 employees. Because of fluctuations in demand, the firms' employee base fluctuates accordingly. The acquisition of a U.S. corporation made clear that the integration of the two firms would become an issue.

4.3.2 *Needed strategic flexibility*

To respond to the changing markets, the firm works closely with suppliers and other third parties. Communication and information form the backbone for the highly integrated chains, including products and manufacturing-chains at the customer site. IT support for strategic flexibility in terms of

fast cooperation and communication with external partners has to improve. The development of three months forecasts with external partners to respond to the changing market is now supported by a flexible and consolidated technical IT infrastructure. Also, the application of new technologies worldwide has to be made easier by implementing firm-wide architecture standards.

IT infrastructure support for strategic flexibility in terms of the worldwide ability to scale up and down also has to become easier. The expansion in new markets or regions and the integration of acquisitions has to improve. Easy worldwide services access of new user groups (e-mail, et cetera) has to be supported by the new infrastructure.

4.3.3 IT infrastructure resource investment

Since management intends to keep meeting its customer needs, to keep improving mobility of its workforce and the ability to work closely with third parties and partners, it decided to invest heavily in IT infrastructure, where IT infrastructure adaptability, availability, flexibility and connectivity were considered essential future assets. Since 2000, the IT-environment that was scattered and optimized at department level was transformed to a centralized environment having the ability to provide for enterprise-wide services and to improve the data and application landscape. The three layers that form the technical fundament of these services are: (1) the data centers, (2) the network layer and (3) the connectivity layer. Upon this fundament, the firm is building the following services: (1) the storage layer, (2) the application and computer layer, (3) the presentation layer, and (4) the client layer.

4.3.4 IT infrastructure capabilities

The new IT infrastructure vision has been translated into IT infrastructure investments that connect continental network and services nodes to local sites, where the continental nodes are connected by a backbone. The network nodes are the central continental connectivity points for connections and access of service nodes. The service nodes provide continental, global or local services to the attached network available for users, customers and suppliers, like applications, email services, storage etc. Combining Internet access with the network-nodes allows for a more central security management by central management of firewall services and disaster planning. IT management considers both development according to architectural principles and building the network layer as essential parts of building a flexible IT infrastructure and gaining support for strategic flexibility.

“Flexibility can only be solved by architecture thinking: thinking in modularity, scalability, in maintainability. For flexibility in technical IT infrastructure the architecture choice is absolutely essential.” Director IT infrastructure

The development of these communication services, security and risk-management services and IT facilities management capabilities by setting (communication) technology standards are seen as a first stage in building a worldwide IT infrastructure. The provided worldwide IT infrastructure services serve as the foundation for building future data management and application infrastructure capabilities. The data storage function has been improved by offering storage as a firm-wide service. In the future the applications landscape will be differentiated in three layers: (1) global services that need to be centrally managed and which are difficult to distribute and synchronise, e.g. SAP, (2) continental services located at the three differentiated continents, e.g. mail and storage services and (3) local functions including heavy applications with large amount of data.

The firm has developed a network and connectivity concept that can support a globally working company and new sites worldwide can easily be added to the firms' infrastructure.

“Because of the acquisition in the U.S. the time to configure the software built in collaboration by programmers in the Netherlands and the U.S. was shortened, augmenting the software storage problems already encountered. By defining our new global storage concept, which is supported by the

new network structure, this service can now be provided for and is scalable in case of future changes.” IT Architect

The development of three months forecasts with external partners to respond to the changing market is now supported by a flexible and consolidated technical IT infrastructure. The firm works with a lot with external suppliers and third parties who source the firms’ services. By implementing network attached storage it is easier to communicate with partners. Mobility is improving worldwide and third parties can get access to (a dedicated part of) the firms’ network. Thin client technology that only requires a browser, will be used as a platform to connect external parties and customers to the firms’ network and provide them with a dedicated working environment. The standard global and continental services can so be delivered. This will provide gain in speed and flexibility to provide services to temporary locations and workplaces. Clients and partners have access to the ERP through the Internet. Worldwide connection of new sites to the infrastructure has improved. Application of new technologies will be easier by implementing firm-wide architecture standards.

4.3.5 *IT flexibility*

The IT management board of the centrally organized IT department consists of the CIO and several directors. The board decides upon budgets for a cluster of activities. These budgets can be allocated to different projects. In general, IT investment decisions are based on a business case and are valued on ROI. IT infrastructure flexibility is explicitly taken into account in the investment process.

“In our projects IT infrastructure flexibility are hard criteria, how to be scalable, how scalable should it be for the upcoming three years. Budget are adjusted to this.” IT architect

Although decision-making is formalized using business cases, responding to emerging issues appears to provide the investment agenda, *“sometimes combined with vision” (IT architect)*. By looking at day-to-day problems and future possible developments, IT capabilities that are necessary for supporting the business are defined and standards are set to develop these capabilities. For example, one of the main triggers that lead to a firm-wide vision on the network-concept was a major storage issue due to an annual data growth of 80%. There is no explicit formalisation in terms of planning and budget for experimentation initiatives. New technologies are most of the time introduced bottom-up by the technicians and architects and by talking to clients. The department responsible for application development projects is a strong supporter for ERP solutions. New ERP solutions, which are built tailor-made, are hardly scalable or generic and hamper integration with other systems, including integration with the ERP-system itself. Application development projects are conducted using classical system development methods, leading to long analysis and development phases. Despite the recent investments in the IT infrastructure, this is strongly felt to hamper support for strategic flexibility.

4.3.6 *IT use*

Since the IT investments in this case comprise large ongoing investments, we can only describe the use of the technology in general. The firms’ business processes vary from having a more explorative nature (e.g., product innovation processes) to having a very exploitative nature (e.g., production processes), to processes that comprise both (e.g., communication processes). Centrally developed applications are mostly built using an ERP solution. These tailor-made ERP solutions are hardly scalable or generic and allow for a very exploitative use. In the production process these solutions are found to support the process very well, also allowing for flexibility needed in the production process to extremely scale up and down production. However, several examples were given where a locally built, flexible application has been rebuilt in the ERP system, which takes out the necessary variation, flexibility and innovation of the organizational processes. This loss of flexibility is made worse by the long application development projects that are needed to build these systems. Despite the recent investments in the IT infrastructure, this is strongly felt to hamper strategic flexibility.

“The flexibility of the technical infrastructure is paying off. Now we bump into inflexibility of applications. People want to collaborate, work in teams, exchange documents. One can build this using SAP, but this represents an old culture, of legacy systems, big consultancy teams. I want to translate scalability to functional applications and offer flexible functionality in within say two weeks to these people.” Director IT infrastructure

At the organizational level, local, non-formalized applications and IT solutions are developed to deal with processes having a more explorative nature.

5 ANALYSIS OF EMPIRICAL FINDINGS

Both described cases focus on specific IT infrastructure investments that are intended to support future strategic flexibility. The firms we studied were both making IT investments that intended to support different strategic flexibility goals. Both firms invested in different IT infrastructure capabilities to support this need in flexibility.

Case	Needed strategic flexibility	IT infrastructure investment	IT infrastructure capabilities
Dutch bank	Improving time-to-market of product innovation to quickly respond to changes in: - customer preferences - competitors' actions	IT platform to enable a multi-channel strategy	Channel management Application infrastructure services
Lithography firm	Improve worldwide ability to: - scale up and down - integrate acquisitions - easily connect to partners	Development of firm-wide IT infrastructure services	Communication services Security and risk-management services IT facilities management services

Table 1. Needed strategic flexibility, IT infrastructure investment and developed IT infrastructure capabilities in both cases

Since the needed strategic flexibility among our cases differs, we can conclude that different types of flexibility needed at the business side, asks for different types of IT infrastructure capabilities. Our cases show evidence that centrally organized *management-oriented* IT infrastructure capabilities (IT management services and IT architecture and standards services) are an essential condition in providing IT infrastructure support for future strategic flexibility. At the moment of the case study research, decentralised management at the lithography firm led to the departmental application silo architecture and the firm is moving to offering central, enterprise-wide, standardized technology services. The bank has reached a stage where standardization of data and processes is involved and intends to move to allow for reusability of software modules. At the lithography firm, the development of communication services, security and risk-management services and IT facilities management capabilities by setting (communication) technology standards are seen as a first stage in building a worldwide IT infrastructure. The provided worldwide IT infrastructure services serve as the foundation for building future data management and application infrastructure capabilities.

We have also tried to analyse how firms invest in IT infrastructure flexibility, how firms identify, track and actively increase the extent of flexibility in the IT infrastructure investment process and how this leads to strategic flexibility.

The cases indicate that flexibility in the *process* of IT infrastructure investment decision-making is implicitly taken into account, whereas IT infrastructure flexibility in terms of the *result* is explicitly valued for. Different criteria are used to prioritise and to make flexible IT infrastructure investments. In the case of the bank these criteria take into account the IT infrastructure flexibility in terms of scalability, reuse and open standards for the applications. The lithography firm uses criteria as scalability, availability, accessibility and connectivity. In one case the IT infrastructure flexibility is

also interpreted as the ability to scale back IT services, reflecting the up- and downturns in business activity as a result of economic cycles.

As for flexibility in the decision-making process, in both cases fast response to changing market conditions is formalized by short decision-cycles. In the case of the bank thinking in real options was implicitly used. The bank invested in the IT platform knowing that the investment could lead to large savings on future application implementations (option to growth). The platform implementation was staged, where the value of a single stage was not dependent on the pursue of a subsequent stage (option to stage). Also, the bank invests in strategic experiments to deploy new technology. Abandonment of these specific investments is explicitly taken into account, although we did not find evidence that project abandonment is actually exercised (option to abandon). The extent to which a project can be deferred is an explicit criterion in the bank's decision-making process (option to defer). However, managerial flexibility that arises from these options was not explicitly valued and common valuation techniques (e.g., ROI) were not integrated with uncertainty modelling so as to capitalize on the value of flexibility. In the lithography firm, it cannot be concluded that option thinking was used. The firm invests in resources on a problem driven basis. Experiments are technology-driven, bottom-up initiated search processes, whereas in the case of the bank, there is a formal budget for these experiments and abandonment is accounted for. In the lithography firm, building tailor-made ERP applications in the main ERP system in long and slow system development projects is felt as very strongly hampering organizational response to change.

In our analysis on how the researched firms use IT to support organizational flexibility, in both cases, management expects more explorative use of applications supported by IT infrastructure investments to better enhance strategic flexibility than exploitative use does. In the case of the bank, IT use of the researched investment is expected to change from exploitative use to explorative use, depending on the applications built and the further development of the platform. The technology was planned to support a more explorative use by devising a new solution to product innovation and service integration, thereby gaining strategic flexibility. At the lithography firm, business processes vary in range from having an explorative nature to having an exploitative nature. Local, non-formalized applications and IT solutions are developed to support processes that allow for a more explorative use. Centrally developed ERP solutions support exploitative use well, but are felt to strongly hamper the support for strategic flexibility in processes where a more explorative use is needed.

6 CONCLUSIONS AND IMPLICATIONS FOR FUTURE RESEARCH

This article, in which the relationship between strategic flexibility and IT infrastructure investments is investigated, provides three contributions. Firstly, in a detailed literature review three perspectives (the resource based view, the real option theory, and organizational learning) provided a general conceptual model that will shed light on the relationships between environmental turbulence, IT infrastructure capabilities, IT infrastructure flexibility, IT use and strategic flexibility. Secondly, the two case studies show how these two companies link their strategic flexibility with the different aspects of IT infrastructure investments. The cases indicate that flexibility in the *process* of IT infrastructure investment decision-making is implicitly taken into account, whereas IT infrastructure flexibility in terms of the *result* is explicitly valued for.

Thirdly, acknowledging the limitations of the study (i.e. exploratory research, basic operationalization, and limited generalization), based on the empirical evidence in these exploratory case studies we suggest that future research should use a more refined research framework. More refined measurements of the constructs need to be developed in order to empirically test and validate the research model. This adds to the variability of the constructs and improves the external validity of the findings. Furthermore, as opposed to the presented model, IT business value as a construct should be added. In the presented cases, we studied two well-performing firms in different industries. Future research should include research in these same industries in firms that differ in their extent of strategic flexibility, to study differences in investment behaviour.

From a practitioner's perspective, the intent of the research is to identify best practices for firms in searching for and managing IT infrastructure investments when aiming for flexibility, and to identify best practices for IT use in order to increase ability to change business strategy.

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