Marianne Kivelä

DYNAMIC CAPABILITIES IN SMALL SOFTWARE FIRMS

HELSINKI SCHOOL OF ECONOMICS

ACTA UNIVERSITATIS OECONOMICAE HELSINGIENSIS

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ABSTRACT

In this dissertation we study dynamic capabilities in small software firms. Small software firms find themselves in highly complex and turbulent environments that require dynamic capabilities to build, integrate and configure resources. While the literature describes a portfolio of such dynamic capabilities that can help firms to adapt to changing conditions, we could not find many definitions, models and studies on these capabilities suitable with particular focus on small software firms. Furthermore, there are currently no comprehensive frameworks available that can help small software firms effectively understand and manage dynamic capabilities. In this dissertation several small software firms are investigated with a case study approach to understand the dynamics in the organizations. Firstly, we identify examples of dynamic capabilities with which these firms adapt to changing environment through knowledge input, processes and resulting software. Then, we indicate the potential of dynamic capabilities in improving small firms' organizational effectiveness. Finally, we present a framework that offers a comprehensive and useful approach to understand dynamic capabilities in small software firms and we suggest on that basis principles for how managers can apply the framework in small software firms.

With this study we have added new knowledge about dynamic capabilities in small software firms. This dissertation makes a contribution to the information systems research by introducing market elements into the software management and development. We suggest that the marketing-related NPD discussion provides valuable insights for developing a new approach of dynamic capabilities to small software firms adapting to changes in their environment. With the help of the suggested approach, we first organized dynamic capabilities offered by the software management and new product development literature into three research streams, which helps outline already existing organizational solutions that help small software firms adapt to changing conditions. Secondly, we provided several illustrative examples of these dynamic capabilities with which small software firms adapt to changes in their environment through knowledge input, modular processes, and resulting software. Finally, one feasible and useful way to understand and manage dynamic capabilities in small software firms was presented.

Keywords: software management, dynamic capability, organizational effectiveness, small software firm

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Helsinki, Finland, March 2007

Marianne Kivelä (born Vainio)

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PART II: THE ORIGINAL PAPERS

PART I: OVERVIEW OF THE DISSERTATION

1 INTRODUCTION

Globalization, acute competition, new information technologies, and emerging customer demands are increasingly redefining business environments. These changes also affect the software industry where firms are to compete on software price, quality, and performance. Gartner research predicts, for example, that electronic devices are effectively turning into standardized commodities because of dropping manufacturing costs (Dulaney 2003). Given the multitude of technology suppliers, software firms increasingly depend on integration and reconfiguration capabilities to respond effectively to evolving customer demands. Similar to other industries (Campbell and Wilson 1996), value chains develop into integrated business networks that deliver value by matching the resources of the participating firms more efficiently and effectively to emerging and diverse customer demands. As a result, software firms today find themselves in highly complex and turbulent environments that require them to build, integrate, and reconfigure resources to adapt to changing conditions.

This trend poses particular challenges for small software firms as they typically operate in high-velocity markets while being constrained by limited and tightly scheduled resources, predominantly fixed costs of development, and often high dependence on one or a few large and powerful players within the industry. Small software firms are therefore extremely vulnerable to changes in technologies and markets. Moreover, given that resource limitations of younger companies make them prone to liabilities of newness and adolescence (Amburgey, Kelly et al. 1993) it may be difficult to identify and develop effective approaches to reconfigure their resources. Finally, because of initial development costs higher marginal returns can be expected mainly from increases in market share. As opposed to institutionalized corporations, small software firms can, nevertheless, more easily deploy their software products to different situations by abstracting knowledge to remove context specific elements. Although it has been established that the large size of the firm has a positive effect on alliance participation (Berg, Duncan et al. 1982), small software firms are attractive partners because of both their innovativeness and flexible

nature, which account for factors associated for positive learning outcomes for both parties (Hamel 1991). However, as these software firms often depend on one or a few larger and more powerful players, their ability to adapt to change is limited.

The resource-based view (Penrose 1959; Barney 1991) suggests that firms are heterogeneous entities differing in capabilities and resources (Wernefelt 1984). Barney's model (1991) assumes that these resources can be valuable, rare, imperfectly imitable and not substitutable. Therefore, they may not be perfectly mobile across firms, and thus heterogeneity can be long lasting (Barney 1991). Building on this view, firms are able to improve their competitive advantage by implementing value-creating strategies that cannot be easily duplicated by competing firms. Moreover, the resource-based view suggests firms can develop dynamic capabilities allowing them to build, integrate, and reconfigure internal and external resources (Teece, Pisano et al. 1997). These capabilities are a set of specific and identifiable processes such as product development, marketing, strategic decision-making, and networking. While the dynamic capability concept is broad and applies to all types of firm processes (Sambamurthy, Bharadwaj et al. June 2003), we focus in this paper on capabilities that help software organizations adapt to changes in their environment. The information systems (IS) and marketing literature offer a portfolio of such dynamic capabilities that are useful for small firms developing software products. In the literature review, we studied such offered capabilities by organizing them into three research streams: 1) how knowledge-intensive inputs to software firms are created and shared, 2) how software processes are managed and configured, and 3) how resulting software is designed and structured.

Dynamic capabilities in small software firms are a current topic. In spite of the challenges in the high-velocity markets, small ventures also often need to maintain a high growth rate. On top of it all, to grow steadily and avoid stagnation, a firm must learn how to move forward into its next stage of evolutionary growth (Greiner 1998), which makes small software firms even more vulnerable to changes in technologies and markets. Despite there being numerous studies on dynamic capabilities, we could not find many definitions, models and studies on how small software firms respond to changes in customer demands, market opportunities, and technology options. Furthermore, there are currently no comprehensive frameworks available that can help small software firms effectively understand and manage dynamic capabilities. Therefore, it is important to study these dynamic capabilities with which small software firms can match to constant change in their environment.

1.1 Background of the Study

In this section, a literature review is presented to position the study. Firstly, we consider the special characteristics of small software firms. Secondly, the resource based theory and the definition of dynamic capabilities are discussed. Finally, we touch on the dynamic capabilities offered by the software management and marketing-related new product development (NPD) literature.

1.1.1 Small Software Firms

Small software firms typically operate in highly changing environments while being constrained by limited and tightly scheduled resources, predominantly fixed costs of development, and high dependence on few large players within the industry. By small firms we mean firms with less than 100 employees. Small software firms have been studied in few research projects in Finland. In their preliminary study, Rautiainen et al. (2002) present a tentative framework for managing software product development in small firms. The study focuses on the relationships between business strategy and software development, and presents a control system for managing development. On the other hand, Sallinen (2002) has studied small software firms with an industrial supplier perspective. She presents a theoretical framework for identifying the factors affecting the development of software supplier firms. The analysis typifies four software suppliers and presents typical development paths of the firms and the most significant resources and capabilities enabling the development identified. Tyrväinen, Warsta and Seppänen (2004) have also addressed the current situation of the Finnish software industry, which well illustrates the context in which small firms compete. While these studies increase our understanding of small software firms, we acknowledge the need for continuing the stream of research from the dynamic capability perspective.

While there is plenty of research about dynamic capabilities within software industry, explaining how these capabilities can be applied particularly in small firms has received little attention. Firstly, small firms find it hard to tailor existing process models to their needs and motivate their developers to follow them (Brodman and Johnson 1994). Although the information systems and marketing-related new product development literature present a large number of techniques, tools and methods for adapting to changing environmental conditions, these have been designed from the perspective of large firms with affluent resources. Secondly, as fixed costs predominate in the development, firms can expect higher marginal returns from increases in market share. In this study it is assumed that growth is the goal of a firm (Van de Ven and Poole 1995). This promise of scale benefits may compel firms to make higher initial investments

in the design of the software architecture. Financing growth increases even more challenges for small firms. The growth perspective involves the identification of certain development stages and has been inspired by the idea that each firm has a certain life cycle (Churchill and Lewis 1983; Kazanjian 1988; Greiner 1998). This indicates that to grow successfully small firms need to maintain flexible management structures to allow evolution. Finally, very little guidance exists to help small firms manage dependence on key customers (Sallinen 2002). For example, there might only be one key customer and the actions of that one customer then have a significant impact on the firm's possibilities to adapt.

1.1.2 The Resource-Based View and Dynamic Capabilities

According to the resource-based view (Penrose 1959; Barney 1991) firms are heterogeneous entities differing in capabilities and resources (Wernefelt 1984). The term "resource-based" was introduced by Wernefelt (1984) in his characterization of firms as collections of resources rather than sets of product-market positions. To have the potential of sustained competitive advantage, a firm resource must have four attributes: 1) it must be valuable in the sense that it exploits opportunities or neutralizes threats in a firm's environment, 2) it must be rare among a firm's current and potential competition, 3) it must be imperfectly imitable, and 4) there can not be strategically equivalent substitutes for this resource (Barney 1991). Resource complementarities enhance the potential to create sustained competitive advantage (Porter 1996; Nambisan 2002). For example, the ability to offer a complementary product enhances the value of a focal product when the two are used together.

The resource-based view suggests firms can develop dynamic capabilities allowing them to build and reconfigure internal and external resources to address rapidly changing environments (Teece, Pisano et al. 1997; Eisenhardt and Martin 2000). The dynamic capabilities are a set of specific and identifiable processes and routines by which managers alter their resource base – acquire and shed resources, integrate them together, and recombine them – to generate new value-creating strategies (Pisano 1994; Grant 1996; Eisenhardt and Martin 2000). According to Teece et al. (1997) and Eisenhardt and Martin (2000), dynamic capabilities are defined as:

> The firm's processes that use resources, specifically the processes to integrate, reconfigure, gain and release resources – to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die.

Similar definitions are given by other authors too. For example, Kogut and Zander (1992) use the term "combinative capabilities" to describe processes by which firms synthesize, acquire and create knowledge resources. Other similar types of concepts that have been proposed include 'architectural competence' (Henderson and Cockburn 1994), or mere 'capabilities' (Amit and Schoemaker 1993).

Dynamic capabilities consist of routines such as product development, strategic decision making, and alliancing. For example, product development develops tailored responses to customers' needs by snapping together components from a modularized product architecture. An other example is how good project management can by itself lead to an increase in product concept effectiveness, thanks to a leader's ability to induce team members' creativity (Cooper and Kleinschmidt 1997). Resource allocation routines are also used to distribute scarce resources such as product development assets. Strategic decision-making is a dynamic capability in which managers pool their various expertise to make choices that shape the strategic moves of the firm (Eisenhardt 1989; Eisenhardt and Martin 2000). Firms can also access outside knowledge through a number of inter-firm relationships that enable them to get meaningful feedback and to subsequently develop appropriate responses to the environment (Hagedoorn 1993; Gulati 1998; Zahay, Griffin et al. 2004).

We will next discuss how these dynamic capabilities are influenced by market dynamism and their evolution over time. Environmental changes can be incremental or revolutionary (Pettigrew 1985). Eisenhardt and Martin (2000) present that the pattern of effective dynamic capabilities depends on this market dynamism. In moderately dynamic markets change occurs frequently and effective dynamic capabilities rely heavily on existing knowledge. In the high-velocity markets, change becomes non-linear and less predictable and dynamic capabilities rely extensively on new knowledge created for specific situations. Due to constant market change, small software firms are today subject to highly complex and turbulent environments. Therefore, such management principles that in simple and clear terms communicate the purpose of business and the values that define what people are expected to do and not to do help keep managers focused on important issues (Haeckel 1999; Eisenhardt and Martin 2000). As all signals in the environment can not be sensed and responded to, it is crucial where organizations choose to place their antennas and how they distinguish relevant signals that improve their effectiveness. Hence, effective dynamic capabilities in the high-velocity markets are simple and they are specified by values that define boundary conditions indicating priorities of an organization (Haeckel 1999; Eisenhardt and Martin 2000).

In addition to market dynamism, previous experience and learning affect how effectively an organization can use the dynamic capabilities to achieve new resource configurations. For example, Kale, Dyer and

Singh (2000), in a study of alliances, present that firms with greater alliance experience and, more importantly, those that create a dedicated alliance function realize greater success with alliances. The dedicated alliance function provides an important mechanism through which know-how can be articulated, codified and shared within the organization. Cohen and Levinthal (1990) also argue that a firm's technology adoption is affected by the degree to which an innovation is related to the pre-existing knowledge base. The authors call this knowledge base as a firm's absorptive capacity (Cohen and Levinthal 1990). Repeated practice helps people to understand processes more fully and so develop more effective routines. Often technology is used to increase this learning (Haeckel 1999).

Dynamic capabilities also exhibit commonalities across firms that are associated with superior effectiveness (Eisenhardt and Martin 2000). These commonalities suggest that dynamic capabilities are equifinal such that firms can develop these capabilities from many starting points and along different paths. In other words, just as there are better and worse ways to hit a tennis ball, there are more or less effective ways to execute particular dynamic capabilities in small software firms. Eisenhardt and Martin (2000) call these 'best practices.'

Therefore, building on Eisenhardt and Martin (2000), this study sheds light on the generalizable nature of dynamic capabilities in small software firms. For example, effective product development routines involve the participation of cross-functional teams that bring together different sources of expertise (Calantone, Vickery et al. 1995; Cooper 2000). Effective software development may also involve routines in which a prototype is developed to support communication by visualization and simulation (Sommerville 2001). In this dissertation we try to study these commonalities for effective specific dynamic capabilities across small software firms in more detail and develop a comprehensive approach how to understand and manage these dynamic capabilities in such firms. It is important to study how enhanced adaptive practices can be developed across small software firms subject to highly complex and turbulent environments that require them to continuously to adapt to emerging needs and opportunities.

1.1.3 Dynamic Capabilities in Small Software Firms

Researchers have argued for a variety of organizational solutions that help firms adapt to changing conditions (Brown and Eisenhardt 1995; Volberda 1998). In this dissertation, we have considered the software management and new product development (NPD) literature and viewed software firms as open systems that interact with their environment through inputs, processes, and outputs. We have first looked at insights from the literature that suggests how knowledge for software development is created and shared

(input). Secondly, we have considered insights on how to configure and manage software development (process). Thirdly, we have looked at contributions on how to design and structure the resulting software (output). While the dynamic capability concept is broad and applies to all types of firm processes such as sales, marketing and logistics (Sambamurthy, Bharadwaj et al. June 2003), we focus in this dissertation on capabilities that help small software organizations adapt to changes in their environment.

The first stream of literature focuses on key inputs to software firms. Since software development is a knowledge-intensive activity, management of knowledge resources is especially critical: generating and exploiting knowledge in high-technology sectors demands that knowledge is continually replenished (Kogut and Zander 1992; Grant 1996; Zahay, Griffin et al. 2004; Kelley and Nakosteen 2005). To effectively use knowledge assets for software development, information must be made available throughout the organization and throughout the relevant stages of development. As Mata et al. (1995) present, successful firms increase flexibility by fostering a culture of communication and integration, because knowledge creation and sharing are likely to lead to greater degrees of integration between functions. Limited interaction, in contrast, can lead to ills and fallacies and an inability to discover the complexity of a given domain.

Information should also be incorporated from many sources to reduce the uncertainty associated with the market success of software product. To gain competitive advantage, firms need to understand customers and markets and integrate this knowledge appropriately with technical knowledge. Customers and users are therefore important sources of innovation and firms are encouraged to commit considerable resources to build sustainable, long-term customer relationships (McGrath 2001; Nambisan 2001). Many studies show, for example, that cross-functional teams are useful in integrating the stream of market information with overall development effort (Barczak 1995; Griffin 1997). Another consideration in managing information relevant to software firms is that different types of information convey different meaning (Daft and Lengel 1986). So-called rich information helps to carry with it a full range of cause and meaning, why it is proposed to be suitable for resolving equivocal situations. On the other hand, lean media such as written documents is proposed to be more suitable for reducing uncertainty. Furthermore, so-called social capital enables firms to enhance the depth, breath, and efficiency of mutual knowledge exchange in relationships (Nahapiet and Ghoshal 1998). This social capital consists of, for instance, close social interaction, shared languages, and trust. Although this need for effective knowledge management capabilities is widely recognized and supported in the software management and NPD literature (Curtis, Kellner et al. 1992; Keil and Carmel 1995; Bommer and Jalajas 2004; Zahay, Griffin et al. 2004) we have

found no approaches that can help small software firms manage knowledge creation and sharing efforts in response to changing customer and market needs.

The second stream of literature is about configuring and managing the process of developing software. Some researchers have emphasized a well-structured process (Cooper 1990; Kruchten 1996), arguing that incremental commitments and suitable development methods can increase a firm's adaptability. A well balanced, complete and disciplined product development process enhances the utilization of information and the effectiveness of decision-making (Clark and Wheelwright 1993; De Maio, Verganti et al. 1994; Hart and Baker 1994) thus establishing the necessary structures for dealing with an uncertain environment. Moreover, key activities such as screening, market research, customer trials, and market launch should not be forgotten, as the balance between market-oriented and technical activities is important (Cooper 2000). Several studies (Adler, McDonald et al. 1992; Calantone, Schmidt et al. 1997; Calantone, Droge et al. 2002) also point out that an organization needs to carefully tailor the chosen framework to its own unique context, using the characteristics most appropriate to its industry and strategic priorities. Therefore, collecting, interpreting, and internalizing technological and marketing capabilities from past projects and incorporating that pre-existing knowledge in a systematic and purposeful manner into new projects increase product development success and long-term competitive advantage (Cohen and Levinthal 1990; Marsh and Stock 2003).

The software literature has also promoted lighter, nimbler, and more flexible development practices (Fitzgerald 1996; Highsmith and Cockburn 2001; Cockburn 2002; Ramesh, Pries-Heje et al. 2002) to respond efficiently and effectively to changing customer needs. Some authors (Baskerville, Levine et al. 2002) claim that these agile approaches share fundamental principles with traditional methods. Proponents of agile approaches argue, however, that traditional methods are too mechanistic and rigid. Either way, the analysis of agile approaches by Abrahamsson et al. (2003) reveals that life-cycle of the agile methods coverage remains partial, comprehensive support for project management is missing, emphasis should be placed on enabling organizations to utilize the suggestions made, and more work is needed on how to adopt agile approaches in different organizational contexts. As Truex at al. (2000) suggest, there is a need to develop forms of software development that integrate activity-level and firm-level capabilities to respond effectively to uncertainty and unpredictable change.

The third stream of research focuses mainly on the output of software firms. This stream provides insights into how component-based architectures can help achieve flexible software (Newman, Podgurski et al. 2000; Sparling 2000; Oshri and Newell 2005). Flexible structures can reduce cycle time and help respond more effectively to changing customer and market demands. A component-based software architecture

implements a collection of common elements, particularly the underlying technology elements, across a range of products and platforms allowing desired individual features and application functions to be rapidly configured for specific customer requests (McGrath 2001). This approach helps a firm reduce the cost of developing individual product variants thanks to reuse of a common product platform (Cooper, Edgett et al. 1999). Other research (Sawyer 2001) focuses on facilitating market-oriented development by increasing dependence on packaged software. Although component-based architectures improve a firm's capability to respond in a profitable and timely way to emerging needs, these approaches primarily target the structuring of the software rather than the organization of the firm that develops and innovates the software. Software architectures can, however, be viewed as coordination mechanisms (Baskerville and Pries-Heje 2004). The relationship between software architectures and enterprise architectures as enablers of dynamic capabilities is therefore an interesting avenue for exploration.

Small software firms need dynamic capabilities to adapt to the changing environment. These capabilities help them identify relevant signals, evaluate impacts on existing and future processes and products, and design and prioritize appropriate responses. Sheramata (2002) suggests that firms that respond to given problems are less successful in attaining their goals than firms that actively identify new problems and opportunities. Small software firms should therefore process information about demands and opportunities through continuous interaction with the environment. For a new or small venture with limited resources and often being highly dependent on few large customers, it is a challenge to develop and sustain such dynamic capabilities.

1.2 Objectives of the Study

This study is about dynamic capabilities that help small software firms adapt to changes in their environment. Its objectives can be broadly specified as follows:

1) To study how the current development approaches help small software firms adapt to changes in customer demands, market opportunities and technology options.

2) To propose a new approach of dynamic capabilities to small software firms adapting to changes in their environment.

    a) To identify the dynamic capabilities with which small software firms adapt to changes in their environment.

b) To study the potential of the dynamic capabilities with which small software firms adapt to changes in their environment.

c) To study how to understand and manage the dynamic capabilities in small software firms.

This dissertation consists of four papers addressing these objectives. The first paper, *Developing Software Products for Mobile Markets: Need for Rethinking Development Models and Practices* (Vainio, Tuunanen et al. 2004), based on a theoretical comparison of four models, investigated how the existing IS approaches help a firm respond to changes in customer demands, market opportunities, and technology options. Furthermore, in the first paper, we studied whether the marketing-related NPD discussion could offer valuable insights for refining a new approach of capabilities needed by small software firms adapting to changes in their environment.

In the second paper, *Communication Flows in Software Product Development: A Case Study of Two Mobile Software Firms* (Tuunanen and Vainio 2005), we aimed at identifying the dynamic capabilities with which two small software firms respond to change in their environment. We applied both the IS and the NPD development approaches as a research lens and studied the interactions of the two firms with their environment.

In the third paper, *Exchange and Combination of Knowledge-Based Resources in Network Relationships: A Study of Software Firms in Finland* (Vainio 2005), we created a theory-based framework for the dynamic capabilities of exchange and combination of knowledge-based resources in inter-firm relationships. A total of 36 different types of relationships of nine small software firms were first placed in the model and then the effectiveness of such relationships were measured. The study increased our understanding of the potential of dynamic capabilities with which small software firms achieved new resource configurations through alliancing.

In the fourth paper, *Dynamic Capabilities in Small Software Firms: A Sense-and-Respond Approach* (Mathiassen and Vainio 2005), we adopted a theoretical framework (Haeckel 1995; Haeckel 1999) as a research lens to study how to understand and manage dynamic capabilities in two small software firms.

1.3 Outline of the Study

This dissertation consists of two parts. Part I, *Overview of the Dissertation*, introduces the research area, describes the objectives of the study, as well as research methodology used, reviews the main results of

the papers, relates the results of the papers to the objectives of the study, and finally presents conclusions and contributions. Part II, *The Original Papers*, consists of four separate articles presenting different research efforts into addressing the objectives of this dissertation.

2 RESEARCH METHODOLOGY

Qualitative research approach was taken in order to gain deeper understanding of dynamic capabilities in small software firms. At first, we conducted an extensive literature review that also produced a comparative analysis presented in the first paper. We could find only few studies, models and definitions suitable for this complex social phenomenon of small software firms adapting to change in their environment. Therefore, several small software firms were studied using the case study approach (Yin 1994) to understand the dynamics in the organizations. The how-nature of the research objectives combined with the focus on contemporary events in small software firms suggested that a case study approach was appropriate (Yin 1994). The adopted interpretive approach (Walsham 1993) allowed us to investigate and explain not only how members of small software firms act, but also why they act as they do in response to changes in their environment (Orlikowski and Baroudi 1991; Klein and Myers 1999). The case study approach includes different data collection methods and provides many sources of evidence to help reach a deep understanding of phenomenon and to ensure satisfactory validity of the findings (Eisenhardt 1989; Yin 1994). The goal was not to produce generalizable results, but to develop pertinent hypotheses and propositions for further inquiry. We aimed at offering novel contribution that helps shed light on dynamic capabilities in small software firms. Therefore, the chosen research methodology is in line with our research objectives.

Selection of the case companies and a more detailed account of research methods applied in each study are described separately for each project in the following sections. We will describe below the research methodology in each paper.

2.1 Small Software Firms' Need to Respond to Changes in their Environment

In this study (Vainio, Tuunanen et al. 2004) we investigated how the existing IS process approaches help a firm respond to changes in customer demands, market opportunities and technology options. We also examined whether the marketing-related NPD discussion could offer valuable insights for refining a new approach of dynamic capabilities to small software firms adapting to changes in their environment.

Based on the literature review of software management and NPD, we chose four process models for the basis of comparison. The NPD models were Generic Development Process (Ulrich and Eppinger 2000) and StageGate (Cooper 2000). The Rational Unified Process (Kruchten 1996) and the extreme programming (XP) method represented the IS models. Then we analyzed how the theoretical models contribute to the management of dynamic capabilities in small software firms. The models chosen are illustrative examples of the current main trends of both the IS and the NPD research streams, respectively. The comparison was organized on the basis of method life-cycle coverage (McGrath 1996; Abrahamsson, Warsta et al. 2003). The life-cycle perspective was needed for determining which phases of the development process are covered by the studied models.

Apart from the model-specific practices, we placed emphasis on analyzing how the methods support abstracting internal and external knowledge obtained throughout the whole development process. We systematically identified the source of information, how the information is processed and analyzed, and the likely output of a stage in light of information. This analysis enabled us to identify how the information delivered from different sources is implemented in the process and how the information is used for the development of product specification.

2.2 Identifying Dynamic Capabilities in Small Software Firms

In this study (Tuunanen and Vainio 2005) we identified dynamic capabilities with which two small software firms adapt to changes in their environment. The interactions of the firms with their environment were studied by applying the NPD approach and the IS development methods as a research lens. The chosen lens helped to focus the study more accurately and shape the design of the study (Eisenhardt 1989; Klein and Myers 1999) therefore creating a firmer empirical grounding for drawing implications. The research was designed as an interpretative case study.

The case selection was based on replication logic to obtain information from comparable cases (Glaser and Strauss 1967; Orlikowski 1993). The two firms operated in similar contexts and had similar goals, but they were in different stages of development. We selected two small, Finnish software firms that both seek high growth based on initial venture capitalists' investments. In contrast, the two firms differ on dimensions such as size, available resources, management and culture. These differences in organizational conditions allowed us to make contrasting interpretations during data analysis. Replication adds confidence and robustness to the findings, but it does not ensure generalizable results (Miles and Huberman 1994; Yin 1994).

To ensure rich data from the two firms, we collected evidence from four sources within each firm (Yin 1994). Firstly, we acquired written material including brochures, annual reports, internal documents, and trade journal articles about the firms. Secondly, we used archives such as marketing presentations, organizational records, project documentation, and customer records. Thirdly, we used observation through site visits. Fourthly, we conducted theme interviews of three types in each firm as the use of multiple respondents enhances the creative potential of the study and builds confidence in the findings (Eisenhardt 1989). The CEO and the head of business development gave us details focusing on management, business development, and marketing issues. Additionally, managers involved in these practical operations offered more details. Finally, the head of software development or the head of technology provided us with details concerning software development practices. The interviews were taped and notes were taken simultaneously.

In a first rough data analysis, we studied financial information from 2000 to 2003, future estimates for 2004, strategy and operating plans, organization structure, and product white papers to focus and plan the detailed data collection through interviews and site visits. Then, in line with the studies (Eisenhardt 1989; Miles and Huberman 1994; Yin 1994), we analyzed this detailed data from different perspectives. To begin with we identified the participants involved in each development phase and the communication flows between them in each firm. Secondly, we identified the level of intentional involvement for each party of the development. Both of the analyses were theory-driven. The results of the two analyses allowed us to make comparisons between the firms. Finally, the data collected in each firm was used for a detailed analysis in which we formed a conceptual model reflecting the development phases and the connecting links between the phases in both firms. The NPD approach and the IS development literature were employed as a basis for the conceptualization.

2.3 Indicating Potential of Dynamic Capabilities in Small Software Firms

In this paper (Vainio 2005) we investigated the potential of the dynamic capabilities with which small software firms adapt to changes in their environment. On the basis of literature, we presented a model for the dynamic capabilities of combining and exchanging knowledge-based resources in inter-firm relationships. With the help of the classification, we were able to study how exchange and combination of knowledge-based resources are regulated by the “value-system” describing the nature of resource combination and “social capital” illustrating how the exchange is facilitated by social interaction, network

ties and trust embedded in relationships. The framework of the two dimensions creating four combinations is presented in Figure 1.

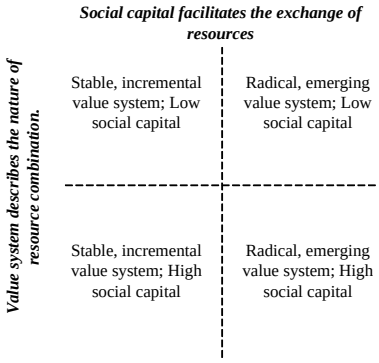

FIGURE 1. FRAMEWORK OF VALUE CREATION IN NETWORK RELATIONSHIPS (VAINIO 2005).

The study was based on a multiple case-study including nine young Finnish firms. The firms were selected due to their growth intentions, small size and the variation of their products. The cases can also be described as a convenience sample because the researcher had previously been cooperating with the firms. The methods used in this study for data collection were theme interviews, structured interviews, and acquisitions of written documents and information from the firms chosen. The purpose was to collect information for a classification of relationships in terms of resource exchange and combination and for measuring the organizational effectiveness gained from such relationships.

The nine firms studied showed a total of 36 different types of relationship. The study took into account only the relationships that complemented the software product of a firm. Firstly, the relationships were arranged in the model by conducting a two-hour theme interview in each firm. The main informant of the interview was the CEO, a partner manager or a sales director. After all of the relationships were arranged into the four combinations, we noticed that there were no relationships representing one category. For this reason, it was not possible to measure the effectiveness of such relationships, but only to draw some conclusions of this non-appearance.

Secondly, after grouping the relationships in the four combinations of the model, the average effectiveness of the existing three relationship types was measured. A structured interview was designed to measure the organizational advantage gained from a relationship. Structured interviews are a good method for testing formal hypotheses and presenting the collected data in a quantitative form (Robson 1995). Quinn and

Rohrbaugh's (Quinn and Rohrbaugh 1983) framework of organizational effectiveness was used to measure the value appropriation. The widely used framework was chosen due to the fact that it comprises an overall framework for analyzing multi-dimensional behavior taking place in organizations. More details about the framework and how the effectiveness items were defined can be found in the original paper (Vainio 2005).

2.4 Understanding and Managing Dynamic Capabilities in Small Software Firms

To study how the dynamic capabilities are managed in small software firms, we conducted a qualitative, multi-level case study (Mathiassen and Vainio 2005). The chosen framework by Haeckel (1995; 1999) helped us focus the study and shape data collection and analysis (Klein and Myers 1999; Mason 2004). The two-level research design allowed us to investigate sense-and-respond practices on the activity-level and consider the firm-level mechanisms that shape these practices. We adopted the interpretive approach (Walsham 1993) that allowed us to investigate how members of the two firms acted in real-life context (Orlikowski and Baroudi 1991; Klein and Myers 1999).

As well as in the second paper, the case selection was based on replication logic to obtain information from comparable cases. The chosen two firms were selected for their similarities, as well as their differences. Hence we adopted literal replication (Miles and Huberman 1994; Yin 1994) hoping to learn that Haeckel's framework was useful across firms and combined it with theoretical replication (Miles and Huberman 1994; Yin 1994) hoping to find contrasting adaptive practices between firms. Evidence was collected by acquiring written material, using archives, using observation through site visits, and conducting theme interviews.

The purpose of data analysis was to offer knowledge regarding the applicability of the chosen framework as a lens to understand dynamic capabilities in the two firms. In line with the studies (Miles and Huberman 1994; Yin 1994) we analyzed the collected data from different perspectives. Firstly, we conducted a within case analysis of each firm. On the activity-level, we analyzed sense-and-respond behavior using Haeckel's cycle (Haeckel 1999). Subsequently, on the firm-level, we identified enablers and barriers for sense-and-respond behavior across the identified activities. This analysis helped us understand the mechanisms that shaped sense-and-respond practices in each firm. Secondly, we conducted a cross-case analysis (Miles and Huberman 1994) using Haeckel's four principles for adaptive enterprise design (1995) to compare and contrast practices across the two firms.

3 REVIEW OF THE RESULTS

We will next review the results of each separate paper in this dissertation.

3.1 New Approach to Software Development in Small Firms

Software product development requires the incorporation of market elements to the software development in order to gain a wide customer-base for the product. In this study (Vainio, Tuunanen et al. 2004), we tried to demonstrate the shortcomings of the current IS and software engineering development methods by taking into account the information management contributing to the market success of software product. We also reviewed the marketing-related NPD discussion in order to investigate whether this perspective could offer valuable definitions, concepts, and models for refining a new approach of dynamic capabilities to small software firms adapting to change in their environment. The theory-based comparison included four illustrative examples of the current main trends of both the IS and the NPD research streams. The models were chosen because of their life-cycle coverage.

The results indicate that the IS process literature views the relationships with the environment as transaction-oriented and based on specific projects. These established relational mechanisms facilitate only limited information sharing. Although leveraging internal expertise provides time and cost advantages, a firm can fail to incorporate market elements into product development without continuously refining the business case through relationships with its environment. In contrast, the product sector calls for relationships that can support the sharing and generating of knowledge (Nambisan 2001). The results also show that the NPD processes are clearly more market-oriented and produce more diversified knowledge pre and especially post-development. As opposed to the IS methods, the abstraction of information places more importance on the market opportunities, customers demands and technology options than on context specific organizations and users.

Although the IS development methods and the NPD ones excel in their own fields, there is no comprehensive view to software product development. The objective of NPD systems is to create new, successful product designs, while IS processes aim to analyze, design, and implement improvements in the functioning of businesses. The former focuses on the information about business objectives, customers, competitive environment and on the alignment with internal functions, while the latter is strongly based on the knowledge of how IS and the latest technological developments can be used for the benefit of the customer. Although the IS literature specifies several causes for uncertainty in software development

(Barki, Rivard et al. 1993; Boehm, Clark et al. 1995), the main identified risk categories are project-related, affecting project schedule and resources, and technological, affecting the quality or performance of software being developed. From the IS perspective, business risks affect the organization developing the software, which indicates that business risk management is not incorporated as such into the existing approaches. To summarize, it can be presented that the current IS approaches fail to incorporate market elements into the development as they ignore the emphasis on upfront business planning and late-phase launch preparation, making the software development unbalanced.

On the basis of the findings, we suggest that the marketing-related NPD discussion provides the IS discipline with valuable insights for refining a new approach of dynamic capabilities that help small software firms adapt to changes in their environment. To gain a wide customer base for a resulting software, there is a need to justify the innovation process stage decision through a continuously evolving discourse of the various parties involved (Kogut and Zander 1992; Grant 1996; Zahay, Griffin et al. 2004; Kelley and Nakosteen 2005). Through this approach, the accumulated information can be used to decrease both technical and business risks. The NPD literature also provides development methods and concepts that attempt to build success into the process by designing stages for gathering the market information needed to lower the business risk (for example Cooper 2000). However, the stage-gate approach (Cooper 2000) is rather similar to the linear waterfall process, which can, for instance, make the accommodation of the newest agile methodologies difficult. This suggests that there is room for a balanced approach to which the iterative software development practices could be accommodated. For example, new agile methods seek to create a working version of the product as early as possible that enables developers to get feedback rapidly (Beck 1999). Many studies of the NPD literature also point out how to design and structure the resulting software. For example, by leveraging the potential for product to complement one another (Dhebar 1995; Sengupta 1998; Nambisan 2002), a small software firm can gain larger market size and make it more costly for customers to switch. Capabilities such as dynamic portfolio management (Cooper, Edgett et al. 1999; Krishnan and Gupta 2001; Cusumano and Gawer 2002), product strategy (McGrath 2001; McGrath 2004), and flexible component-based architectures (Newman, Podgurski et al. 2000; Sparling 2000; Oshri and Newell 2005) also give firms opportunities to develop and optimize the market responsiveness of their software.

3.2 Dynamic Capabilities in Two Small Software Firms

In this study (Tuunanen and Vainio 2005) we investigated dynamic capabilities in two small software firms. The IS development methods and the NPD approach were applied as a lens to identify how the two firms adapted to change in their environment throughout the phases of software development. In line with the studies (Chiesa, Coughlan et al. 1996; Cooper 2000), we presented that the NPD framework especially contributes to interactions with other business dimensions and firms' environment. The complex and turbulent environment of today's software firms stresses the need to effectively integrate the knowledge from various sources in order to enhance the market responsiveness of products.

In this study, we identified the dynamic capabilities used in two software firms. We found out that the IS and the NPD processes were highly intertwined by intensive information management throughout software development, the balanced approach to development with cross-functional teams, and a flexible component-based architecture. Firstly, the two firms configured knowledge-based resources throughout organization and development by processing different types of information from various sources. By doing this, they identified the main obstacles that needed to be worked on to get the process to be more flexible. In both of the firms, information was gathered from several sources. However, the findings show that the other, more mature, firm collected intensively richer data from the market. This rich data consisted of both explicit input, such as business analyses, technical assessments, and systematic calculations, and informal discussions with stakeholders. Additionally, the information sources were more plentiful and the direction of communication was more two-way. The other firm relied only on informal, face-to-face discussions and nothing but a few pieces of information were explicit.

To support the communication between the stakeholders involved in the process, both firms delivered prototypes to visualize and simulate the produced output. Contrary to the traditional approach where prototyping is used primarily as an engineering tool for managing technical risks and test feasibility (Sommerville 2001), feedback was gathered from the environment in order to adjust plans according to the gained information. In addition to managing technical risks, it appeared that the prototype was also built to manage business risks with regular feedback loops. For example, sales teams of the two firms collected customer feedback by delivering prototypes in each of the phases. However, in the more mature firm the output of the phases was also augmented by explicit means, such as prelim financial and business analyses, action plans, transition and operation plans, brochures, and after sales survey.

Secondly, this collected information was configured and managed with the help of a well-structured, incremental process. The decision-making in both firms turned out to be coordinated on a milestone basis,

which resembled the stage-gate product development process (Cooper 1990). However, both firms had adjusted the high level staged process to accommodate the iterative software development practices. These structured iterations reflected a software product's component-based architecture. This incremental approach supported the rapid creation of a partially functioning version of the product. Additionally, this approach provided the fine balance between agility and control: executives valued the emphasis on up-front business planning and late-phase launch preparation, managers used the iteration-end dates as intermediate milestones to better control the schedule and scope, developers liked the agile way of working as they proceeded towards a solution during implementation and testers were able to begin their work earlier in the process and were thus able to identify defects early. Although the underlying template of the process was the same, in the more mature firm the lines between the phases were more formal and decision-making relied on more plentiful information. This firm also started gathering in-depth feedback of a product concept already in the first phases of the process, whereas the other firm engaged stakeholders clearly in the later phases. Collected feedback gave them a sense of confidence to act quickly.

In line with literature (Barczak 1995; Calantone, Vickery et al. 1995; Griffin 1997), the results also show that cross-functional teams are useful in integrating the stream of information. In both of the firms, several stakeholders contributed to align the internal perspectives with a common understanding of customers' context and requirements. It also appears that these relationships between different functions can be significantly strengthened by intensive and rich communication such as face-to-face meetings.

And thirdly, the incremental process and product design were intertwined through a component-based architecture. The findings show that software architecture was viewed from the standpoint of rapidly creating a version of the product. Rather than creating the entire product, a functional version with only a portion of the feature set was created as early as possible. And after the essence of the system was developed, they worked on the other features. This indicates that the requirements were not frozen, because the design changes were built into the process by reacting continuously to information received.

Finally, the findings demonstrate there were similarities in the dynamic capabilities identified between the two firms. In line with Eisenhardt and Martin (2000), the patterns of effective dynamic capabilities depend upon market dynamism, but on the basis of our findings we can propose that also the maturity of a firm has an effect on how the dynamic capabilities are practiced. This finding supports the argument that the evolution of dynamic capabilities is guided by learning mechanisms (Eisenhardt and Martin 2000). Our analyses revealed important variations in adaptive practices as a reflection of the two firm's maturity level. Because of longer history, the more mature firm had been able to evaluate and reflect on their

performance against past development efforts. This experience helped coordinate inputs, processes, and responses in a systemic way. On the other hand, the other firm had recently peaked and became more complex while bringing together different sources of expertise was performed in an ad hoc fashion.

3.3 Potential of Dynamic Capabilities in the Relationships of Nine Small Software Firms

In the third paper (Vainio 2005), we investigated the potential of dynamic capabilities in inter-firm relationships of small software firms. We classified the relationships of the chosen firms in terms of exchange and combination of knowledge-based resources and identified distinctions with respect to the potential of such relationships. Partnerships with other organizations constitute valuable capital by providing access to complementary resources and capabilities that may otherwise be unavailable (Penrose 1959; Barney 1991). In this study, the potential helped these firms improve their organizational effectiveness, and, subsequently, develop appropriate response to changing environmental conditions.

On the basis of the literature, we created a framework for the dynamic capabilities of exchanging and combining knowledge-based resources in inter-firm relationships. The “value-system” describes that value can be created either by combining elements previously unconnected or by developing novel ways of combining resources previously associated. “Social capital” illustrates how the exchange is facilitated by social interaction, network ties and trust embedded in relationships. Subsequently, the relationships of nine Finnish small software firms were first classified and placed in the framework, and then the organizational effectiveness of the relationships was measured. The results revealed three types of relationships in terms of exchange and combination of knowledge-based resources, each leading to different effectiveness profiles.

Firstly, the relationships of a stable, incremental value system bundled with high social capital was found to contribute equally to all major organizational functions. The findings suggest that this type of familiar and stable context involving an incremental development approach is suitable for increasing flexibility and competitiveness in risk-averse high technology sectors. An example of these relationships is a highly coordinated and strong OEM agreement in which a small firm exchanged special technological skills and project resources with a large partner. Secondly, the effect of relationships for the combination of emerging value system and high social capital proved likely to emphasize the flexibility and decentralized structure of an organization. However, the results also indicated that learning and readiness could not be fully exploited by the respective organizations. Due to the emerging context, there was no consistency in implementing improvements in the firm structure. An example of these relationships is an industry forum

that aimed at producing new innovations, market information and radical technology developments through resource mobilization and sharing. Thirdly, the relationships of a stable, incremental value system coupled with low social capital appeared to contribute to the adaptation and goal-attainment capabilities of an organization. Although there was hardly any effect on the quality of internal processes and organizational learning and innovativeness, the relationships contributed to some extent to productivity, efficiency, growth, and resource acquisition. An example is a marketing channel agreement in which one partner provides market access or a brand name, while the other provides the product to market. The shape of the cooperation agreements varied, the strongest occurrences being technology licensing agreements with one partner paying royalties to gain access to the other partner's technology, and the weakest were merely letters of intent. Lastly, as no relationships could be found for the combination of radical, emerging value system and low social capital, it can be concluded that such an inconstant context of loose bonds is not likely to be beneficial for improving the effectiveness of businesses.

In this study we classified the dynamic capabilities by which small software firms achieved new resource configurations in their relationships. Firstly, the results suggest that the nature of value-system and the amount of social capital have an effect on the benefits gained from the exploitation of dynamic capabilities in inter-firm relationships. This is in line with Eisenhardt and Martin (2000) that value-system affects the efficiency of dynamic capabilities. Secondly, the results show that high social capital proved to help tap into the knowledge and thus improve the efficiency of routines. In fact, in the high-velocity markets, where resource combination is radical and emerging, high social capital seems to be a necessity for effective alliancing. It helps to create new, situation-specific knowledge. As in the emerging value system, there is little structure to support capabilities, so they become easy to forget (Argote 1999). It seems that social capital helps to sustain these capabilities. Eisenhardt (1989) also points out that the emotional inability to cope with uncertainty is a major factor that slows down managers in the high-velocity markets. However, social capital in the form of social status and reputation, respect and friendship, trust, and shared languages and codes facilitates the actions of individuals within the organization (Nahapiet and Ghoshal 1998) and therefore it seems to help provide more confident responses to changing conditions.

3.4 Managing Dynamic Capabilities in Two Small Software Firms

In this study (Mathiassen and Vainio 2005), we adopted Haeckel's (1995; 1999) sense-and-respond framework as a lens to investigate how to understand and manage dynamic capabilities in two software

firms. To survive and be successful in turbulent business environments firms must (Kidd 1995; Dove 2001; Sharifi and Zhang 2001; Carrillo and Gaimon 2002): 1) respond to anticipated and unexpected changes in proper ways and due time, and 2) exploit changes and take advantage of change opportunities. Firms with these traits have transformed their strategy, structure, and governance to practice a sense-and-respond mindset (Haeckel 1999) and they have learned to manage and apply knowledge effectively to thrive in continuously changing and unpredictable business environments (Dove 2001). Such adaptive behaviors are enabled by specific dynamic capabilities (Sambamurthy, Bharadwaj et al. June 2003).

Haeckel (1995; 1999) suggests a general sense-and-respond framework that is based on basic assumptions about strategy, structure, and governance in adaptive firms. Strategy should be focused on creating and developing mechanisms that enable responses to change rather than on planning specific actions that implement stated goals; structures should consist of dynamic networks of modular, collaborative capabilities rather than static hierarchies of tasks and responsibilities; and, governance should be achieved through coordination based on shared values and information rather than dedicated command and control activities.

On the activity-level, Haeckel emphasizes response ability (2001) through sense-and-respond cycles in a firm's key processes as illustrated in Figure .

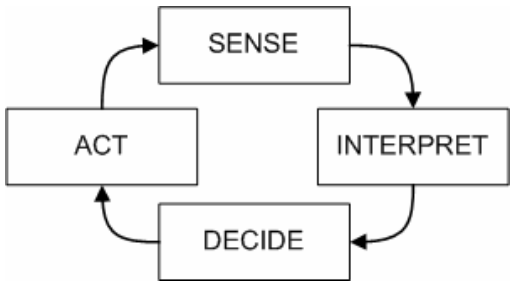

FIGURE 2. THE ADAPTIVE LOOP (HAECKEL 1999).

While sense-and-respond cycles can help adapt to changes in the environment, the question remains of how organizations enable and coordinate actions in a coherent and effective manner. To this end, Haeckel proposes to adopt systemic management on the firm-level. The purpose is to create a context in which all members know how and why activities are executed; in which coordination is provided through shared values and through a uniform language that is spoken across a firm's modular processes; and, in which matching of products and services to current customer preferences and values is facilitated by

reconfigurable repertoires of capabilities (Haeckel 1995; Haeckel 1999; Haeckel 2003; Haeckel 2004). The suggested systemic approach to management seeks to integrate activity-level sense-and-respond cycles with firm-level mechanisms that offer autonomy to act while at the same time maintaining integrity and coordination. This systemic management approach is summarized as four principles for adaptive enterprise design (Haeckel 1995).

The purpose of the case analyses was to offer knowledge regarding the applicability of the sense-and-respond framework to understand and manage dynamic capabilities in small software firms. Firstly, our analyses suggest that the framework integrated activity- and firm-level dynamic capabilities related to input, process, and output aspects of software development. Secondly, the framework revealed important variations in sense-and-respond practices as a reflection of differences in maturity between the two firms. We identified dynamic capabilities related to all four Haeckels's adaptive enterprise principles (Haeckel 1995) in both firms, but the firms demonstrated quite different approaches to how the principles were practiced.

We also combined the insights from the case study with previous knowledge about dynamic capabilities in software organizations to suggest principles for how to apply the sense-and-respond framework to manage small software firms. The principles are hence derived from the analyses and add to Haeckel's generic framework in the particular context of small software firms.

Cultivate external relationships. Adopting a sense-and-respond approach can help small software firms leverage their limited and tightly scheduled resources by cultivating external relationships. Customers and users are important sources of innovation in relation to ongoing software projects and their future directions (McGrath 2001; Nambisan 2001); activities such as screening, market research, customer trials, and market launch can help balance market-oriented and technical activities (Cooper 2000); and, partnerships with other firms can help maintain or improve the firm's competitive position.

Distribute sense-and-respond cycles. Small software firms typically operate in high-velocity markets. They are therefore advised to distribute sense-and-respond capability into their main activities. This engages more people in sensing events in the environment and it increases the organization's overall response ability. A distributed approach requires lighter, nimbler, and flexible software projects (Fitzgerald 1996; Highsmith and Cockburn 2001; Cockburn 2002; Ramesh, Pries-Heje et al. 2002) as well as systematic activities to sense and respond to market needs and technological opportunities (Cooper 2000).

Ensure firm-level coordination. Cultivation of external relationships and distribution of sense-and-respond cycles enhance a firm's dynamic capabilities. However, without appropriate coordination and integration these activities can jeopardize efforts to maintain and improve a strong and focused competitive position. Small software firms are therefore advised to use the sense-and-respond approach to develop software development and management practices that integrate activity-level and firm-level dynamic capabilities (Truex, Baskerville et al. 2000). This can be achieved by communicating the purpose of business and the values that define what people are expected to do and not do (Haeckel 1995); by fostering a culture of communication and integration (Mata, Fuerst et al. 1995); and by systematically collecting, interpreting, and internalizing technological and marketing capabilities from past projects into new projects (Marsh and Stock 2003).

Leverage component-based architectures. Component-based approaches can help small software firms develop flexible software that facilitates efficient engineering practices and effective responses to market dynamics (Newman, Podgurski et al. 2000; Sparling 2000; Oshri and Newell 2005). Component-based architectures need, however, to be leveraged by specific dynamic capabilities.

Balance standardization and customization. Small software firms are typically highly dependent on one or a few large and powerful players within the industry. Under these conditions they have to customize software solutions to particular needs and it can be difficult to develop an effective market-oriented strategy based on standardized components (Sawyer 2001). Small software firms are therefore advised to use a sense-and-respond approach to continuously balance standardization and customization of its software products and services.

4 EVALUATION AND CONCLUSIONS

In this section we conclude Part I of this dissertation by evaluating and concluding the results, summarizing contribution of the dissertation, by presenting possible limitations of the study, and by outlining directions for possible future research in this area.

4.1 Evaluation and Conclusions of the Results

We will next evaluate the results of the separate studies and the dissertation as a whole in relation to the objectives of the study.

This study is about coordinating dynamic capabilities that help small software firms adapt to changes in their environment. The first objective was to study how the current development approaches help small software firms respond to changes in customer demands, market opportunities and technology options. This was achieved with a study of the current models offered by the software management and marketing-related NPD literature. We introduced a theoretical comparison that included four models illustrating examples of the main trends of both the IS and the NPD research streams, respectively. As a result of the study, we identified that the focus of current IS development approaches is on improving processes to produce better and more predictable outcomes, and, therefore, they tend to lack responsiveness to market opportunities. It can be suggested that the IS process approach ignores the emphasis on up-front business planning and late-phase product launch preparation, making the software product development unbalanced.

On the other hand, the NPD literature has provided several studies of knowledge resource management, development methods and concepts, and ways to design and structure the resulting software, such as product strategy and portfolio management. These capabilities attempt to build success into the software development, for example, by optimizing resource utilization, designing stages for gathering the market information, and aligning product development with a firm's strategic priorities. Therefore, we consider the NPD definitions, concepts and models as a possible way of closing this gap between what is currently done in software management and what we believe needs to be done.

The second objective was to identify these dynamic capabilities in small software firms. In a case study of two small software firms, we applied both the NPD approach and the IS development methods as a lens to identify the how the dynamic capabilities were used in practice. We found out that the IS and the NPD processes were highly intertwined by intensive information management throughout software development, by the balanced approach to development with cross-functional teams, and by a flexible component-based architecture. With the help of the applied framework, we were able to produce preliminary results of the capabilities needed for aligning software development to changing conditions in small software firms.

Related to software development inputs, we saw how team members collected and disseminated information and improved knowledge access by forging and nurturing relationships for getting meaningful feedback. Both lean and rich media were used to create and share knowledge. Technology in the form of prototyping was also used to develop more effective communication practices and routines. Related to processes, we saw how software requirements were continuously updated against the collected feedback during the development. The cross-functional teams were also useful in integrating the streams of market

information with the overall development effort. Finally, related to outputs, the analyses show how development teams used modular architectures as coordination mechanism to generate quick responses to specific customer requests. As a synthesis of this study, a preliminary conceptualization was also presented describing the identified dynamic capabilities in the chosen firms.

The third objective was to study the potential of the dynamic capabilities in inter-firm relationships of small software firms. The potential describes how the dynamic capabilities of exchange and combination of knowledge-based resources helped the firms achieve improvements in their organizational effectiveness. On the basis of literature, we presented a framework for the dynamic capabilities of combining and exchanging knowledge-based resources in network relationships. In the empirical research setting, the relationships were first classified and placed in the framework, and then the organizational effectiveness of the relationships was measured. The results reveal three relationships types, each leading to different effectiveness profiles. The findings indicate that all the identified combinations provided value, but for different purposes. However, the study confirms Eisenhardt and Martin's findings (2000) that market dynamisms influences the effectiveness of dynamic capabilities. The exchange and combination of knowledge-based resources in the value systems opposed to each other lead to different effectiveness profiles. Secondly, in line with Nahapiet and Ghoshal (1998), we point out that social capital, in the form of respect, friendship, trust, shared languages and codes, facilitates this resource exchange and thus helps to sustain these dynamic capabilities.

Finally, the fourth objective was to study how to understand and manage these dynamic capabilities in small software firms. We used a sense-and-respond framework as a lens to study dynamic capabilities in two software firms. The framework integrated activity- and firm-level capabilities related to input, process, and output of software development. We argue that the framework offered a comprehensive and useful approach to understand dynamic capabilities in the two firms and we suggest on that basis principles for how managers can apply the framework to small software firms.

The main conclusions of this dissertation are summarized in the following. At first, we conducted a literature review that indicated that the existing IS approaches fail to respond to changes in customer demands, market opportunities and technology options. We proposed that the marketing-related NPD discussion provides the IS discipline with valuable insights for refining a new approach of dynamic capabilities that help small software firms adapt to changes in their environment. By using the new approach as a research lens, we investigated these dynamic capabilities in practice in two small software firms. By identifying how the two firms responded to change, we were able to show illustrative examples of these capabilities. Our analyses also revealed important variations in adaptive practices as a reflection

of the two firms' maturity level. Furthermore, we proved the potential of these dynamic capabilities in inter-firm relationships of small software firms. Exchanging and combining knowledge-based resources improved the organizational effectiveness of nine small software firms and thus helped firms match the change in their environment. Finally, we present one possible framework for understanding and managing these dynamic capabilities in small software firms. The findings show evidence that the chosen framework offered a comprehensive and useful approach to understanding dynamic capabilities in the two firms. On that basis, we suggested the principles for how managers can apply the framework to small software firms.

4.2 Main Contributions

This dissertation makes a contribution to the information systems (IS) research. The focus of current IS development methods is on improving processes to produce better and more predictable results, and, therefore, they tend to lack responsiveness to market opportunities. We suggest that the marketing-related NPD discussion provides valuable insights for developing a new approach of dynamic capabilities to small software firms adapting to changes in their environment. The NPD system especially contributes to interactions with other business dimensions and a firm's environment. This dissertation is one of the first ones to attempt to introduce market elements into the design of software development.

We have also added new knowledge about dynamic capabilities in small software firms. Firstly, we organized dynamic capabilities offered by the software management and new product literature into three research streams, which helps outline already existing organizational solutions that help small software firms adapt to changing conditions. Secondly, we provided several illustrative examples of these dynamic capabilities with which small software firms adapt to changes in their environment through knowledge input, modular processes, and resulting software. Finally, we presented one feasible way to understand and manage dynamic capabilities in small software firms.

Furthermore, the study points out the importance of social capital for the efficiency of dynamic capabilities. Commonalities imply that dynamic capabilities per se are not likely to be sources of sustained competitive advantage. Here we showed that social capital helped to sustain this organizational effectiveness.

For practitioners, we suggest that the findings of the study provide guidance to assess and develop more market-oriented software products in contemporary dynamic environments. For a new venture with

limited resources, in particular, effective co-ordination of dynamic capabilities may offer valuable resources. The study advances the identification of those benefits.

4.3 Limitations of the Study

The results have some limitations because of the design and realization of the empirical investigations. Firstly, the selected cases only include Finnish software firms that seek high growth based on initial venture capitalists' investments. Secondly, the cases exclude non-networking companies, which is why future researchers may wish to consider whether the conclusions are valid across all firms and not just for those already in relationships. Thirdly, we relied on the manager's perspective as we used the organizational approach that focused on the effectiveness of a firm. Therefore some views have been omitted. For example, customers or users may have quite different values and goals in regard to the market success of software products.

Our fourth paper (Mathiassen and Vainio 2005) is exploratory in nature; it is based on a comparative study of two software firms; and, it is informed by a particular view on the adaptive enterprise (Haeckel 1995; Haeckel 1999; Haeckel 2004) without consideration of other possible frameworks (e.g. Dove 2001). Moreover, our analyses focused selectively on particular sense-and-respond activities.

4.4 Future Research

In the future, we are seeking to study dynamic capabilities in more depth.

In this dissertation we focused only on the methods managing the software project and providing full coverage over the development life cycle. Therefore, practices and techniques that are suitable for only specific phases are also worth studying. For example, requirements engineering literature may provide complementing approaches to support software development in small firms.

The cooperation of dynamic capabilities should also be investigated in more empirical settings. One optional direction for future research could be to study other knowledge-intensive industries as well. For example, comparisons between turbulent software industry and some moderately dynamic service sectors could produce interesting results. As the selected cases exclude non-networking firms, future studies may wish to consider whether the conclusions are valid across all firms.

Another interesting direction for continuing the research could be a systematic longitudinal study of a firm. In addition, action research could provide interesting research agenda for a better understanding of the dynamic capabilities needed for managing knowledge-based resources.

As specific dynamic capabilities typically vary across industries, one possible approach would be to develop a framework dedicated to manage dynamic capabilities in small software firms. It is also interesting whether the capabilities can be used for distinguishing firms with a lesser success potential.

REFERENCES

Abrahamsson, P., J. Warsta, et al. (2003). New Directions on Agile Methods: A Comparative Analysis. International Conference on Software Engineering (ICSE25), Portland, Oregon.

Adler, P. S., D. W. McDonald, et al. (1992). "Strategic Management of Technical Functions." Sloan Management Review **33**(2): 19-37.

Amburgey, T. L., D. Kelly, et al. (1993). "Resetting the Clock: The Dynamics of Organizational Change and Failure." Administrative Science Quarterly **38**: 51-73.

Amit, R. and P. J. H. Schoemaker (1993). "Strategic Asset and Organizational Rent." Strategic Management Journal **14**(1): 33-46.

Argote, L. (1999). Organizational Learning: Creating, Retaining, and Transferring Knowledge. Boston, MA, Kluwer Academic.

Barczak, G. (1995). "New Product Strategy, Structure, Process, and Performance in the Telecommunications Industry." Journal of Product Innovation Management **12**(3): 224.

Barki, H., S. Rivard, et al. (1993). "Toward an Assessment of Software Development Risk." Journal of Management Information Systems **10**(2): 203-225.

Barney, J. (1991). "Firm Resources and Sustained Competitive Advantage." Journal of Management **17**(1): 99-120.

Baskerville, R., L. Levine, et al. (2002). Balancing Quality and Agility in Internet Speed Software Development. 23rd International Conference on Information Systems, Barcelona, Spain.

Baskerville, R. and J. Pries-Heje (2004). "Short Cycle Time Systems Development." Information Systems Journal **14**: 237-264.

Beck, K. (1999). "Embracing Change with Extreme Programming." IEEE Computer **32**(10): 70-77.

Berg, S. V., J. Duncan, et al. (1982). Joint Venture Strategies and Corporate Innovation. Gambridge (MA), Oelgeschlager, Gunn & Hain.

Boehm, B. W., B. Clark, et al. (1995). "Cost Model for Future Life Cycle Processes: COCOMO 2." Annals of Software Engineering **1**: 57-94.

Bommer, M. and D. S. Jalajas (2004). "Innovation Sources of Large and Small Technology-Based Firms." IEEE Transactions on Engineering Management **51**(1): 13-18.

Brodman, J. G. and D. L. Johnson (1994). What Small Businesses and Small Organizations Say about the CMM. 16th International Conference on Software Engineering, Sorrento, Italy.

Brown, S. L. and K. M. Eisenhardt (1995). "Product Development: Past Research, Present Findings and Future Directions." Academy of Management Review **20**(2): 343-378.

Calantone, R., C. Droge, et al. (2002). "Investigating the Manufacturing-Marketing Interface in New Product Development: Does Context Affect the Strength of Relationships?" Journal of Operations Management **20**(3): 273-287.

Calantone, R. J., J. B. Schmidt, et al. (1997). "New Product Activities and Performance: The Moderating Role of Environmental Hostility." Journal of Product Innovation Management **14**(3): 179-189.

Calantone, R. J., S. K. Vickery, et al. (1995). "Business Performance and Strategic New Product Development Activities: An Empirical Investigation." Journal of Product Innovation Management **12**(3): 214-223.

Campbell, A. J. and D. T. Wilson (1996). Managed Networks: Creating Strategic Advantage. Networks in Marketing. D. Iacobucci. London, SAGE Publications**:** 125-143.

Carrillo, J. E. and C. Gaimon (2002). "A Framework for Process Change." IEEE Transactions on Engineering Management **49**(4): 409- 427.

Chiesa, V., P. Coughlan, et al. (1996). "Development of a Technical Innovation Audit." Journal of Product Innovation Management **13**(2): 105-136.

Churchill, N. C. and V. L. Lewis (1983). "The Five Stages of Small Business Growth." Harward Business Review **61**(3): 30-50.

Clark, K. B. and S. C. Wheelwright (1993). Managing New Product and Process Development: Text and Cases. New York, The Free Press.

Cockburn, A. (2002). Agile Software Development. Boston, Addison-Wesley.

Cohen, W. M. and D. A. Levinthal (1990). "Absorptive Capacity: A New Perspective on Leaning and Innovation." Administrative Science Quarterly **35**(1): 128-152.

Cooper, R. (2000). "Winning with New Products Doing it Right." IVEY Business Journal **July-August 2000**: 54-60.

Cooper, R. G. (1990). "Stage-Gate Systems - a New Tool for Managing New Products." Business Horizons **33**(3): 44-54.

Cooper, R. G. (2000). Product Leadership: Creating and Launching Superior New Products. New York, Perseus Publishing.

Cooper, R. G., S. J. Edgett, et al. (1999). "New Product Portfolio Management: Practices and Performance." Journal of Product Innovation Management **16**(4): 333-351.

Cooper, R. G. and E. J. Kleinschmidt (1997). "Winning Businesses in Product Development: The Critical Success Factors." Journal of Product Innovation Management **14**(2): 132.

Curtis, B., M. I. Kellner, et al. (1992). "Process Modeling." CACM **35 (9)**: 75-90.

Cusumano, M. A. and A. Gawer (2002). "The Elements of Platform Leadership." MIT Sloan Management Review **43**(3): 51-60.

Daft, R. L. and R. H. Lengel (1986). "Information Richness: A New Approach to Managerial Behaviour and Organizational Design." Management Science.

De Maio, A., R. Verganti, et al. (1994). "A Multi-Project Management Framework for New Product Development." European Journal of Operational Research **78**(2): 178-191.

Dhebar, A. (1995). "Complementarity, Compatibility, and Product Change: Breaking with the Past?" Journal of Product Innovation Management **12**(2): 136-152.

Dove, R. (2001). Response Ability: The Language, Structure, and Culture of the Agile Enterprise. New York, John Wiley & Sons, Inc.

Dulaney, K. (2003). "Predicts 2004: Mobile and Wireless." Gartner Research **AV-21-5094**.

Eisenhardt, K. M. (1989). "Building Theories from Case Study Research." Academy of Management Review **14**(4): 532-550.

Eisenhardt, K. M. (1989). "Making Fast Strategic Decisions in High-Velocity Environments." Academy of Management Journal **32**(3): 543-576.

Eisenhardt, K. M. and J. A. Martin (2000). "Dynamic Capabilities: What Are They?" Strategic Management Journal **21**: 1105-1121.

Fitzgerald, G. (1996). "Formalised Systems Development Methodologies: A Critical Perspective." Information Systems Journal **6**: 3-23.

Glaser, B. and A. Strauss (1967). The Discovery of Grounded Theory: Strategies for Qualitative Research. Chicago, Aldine Publishing Company.

Grant, R. M. (1996). "Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration." Organization Science **7**(4): 375-387.

Greiner, L. E. (1998). "Evolution and Revolution as Organizations Grow." Harvard Business Review.

Griffin, A. (1997). "PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices." Journal of Product Innovation Management **14**(6): 429-458.

Gulati, R. (1998). "Alliances and Networks." Strategic Management Journal **19**: 293-317.

Haeckel, S. H. (1995). "Adaptive Enterprise Design: The Sense-and-Respond Model." Planning Review **23**(3): 6-42.

Haeckel, S. H. (1999). Adaptive Enterprise: Creating and Leading Sense-and-Respond Organizations. Boston, Massachusetts, Harvard Business School Press.

Haeckel, S. H. (2003). "Leading on Demand Businesses - Executives as Architects." IBM Systems Journal **42**(3): 405-413.

Haeckel, S. H. (2004). "Peripheral Vision: Sensing and Acting on Weak Signals Making Meaning out of Apparent Noise: The Need for a New Managerial Framework." Long Range Planning **37**: 181-189.

Hagedoorn, J. (1993). "Understanding the Rationale of Strategic Technology Partnering: Interorganizational Modes of Cooperation and Sectorial Differences." Strategic Management Journal **14**: 371-385.

Hamel, G. (1991). "Competition for Competence and Interpartner Learning within International Strategic Alliances." Strategic Management Journal **12**: 83-103.

Hart, S. J. and M. J. Baker (1994). "The Multiple Convergent Processing Model of New Product Development." International Marketing Review **11**(1): 77-92.

Henderson, R. and I. Cockburn (1994). "Measuring Competence? Exploring Firm Effects in Pharmaceutical Research." Strategic Management Journal(Summer Special Issue 15): 63-84.

Highsmith, J. and A. Cockburn (2001). "Agile Software Development: The Business of Innovation." Computer **34**(9): 120-122.

Kale, P., H. Singh, et al. (2000). "Learning and Protection of Proprietary Assets in Strategic Alliances: Building Relational Capital." Strategic Management Journal **21**: 217-237.

Kazanjian, R. K. (1988). "Relation of Dominant Problems to Stages of Growth in New Technology Ventures." Academy of Management Journal **31**: 257-279.

Keil, M. and E. Carmel (1995). "Customer-Developer Links in Software Development." Communications of the ACM **38**(5): 33-44.

Kelley, D. J. and R. A. Nakosteen (2005). "Technology Resources, Alliances, and Sustained Growth in New, Technology-Based Firms." IEEE Transactions on Engineering Management **52**(3).

Kidd, P. T. (1995). Agile Manufacturing: Forging New Frontiers. Cornwall, Addison Wesley.

Klein, H. K. and M. D. Myers (1999). "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems." MIS Quarterly **23**(1): 67-93.

Kogut, B. and U. Zander (1992). "Knowledge of the Firm, Combinative Capabilities and the Replication of Technology." Organization Science **3**(3): 383-397.

Krishnan, V. and S. Gupta (2001). "Appropriateness and Impact of Platform-Based Product Development." Management Science **47**(1): 52-68.

Kruchten, P. (1996). "A Rational Development Process." Crosstalk **9**(7): 11-16.

Marsh, S. J. and G. N. Stock (2003). "Building Dynamic Capabilities in New Product Development through Intertemporal Integration." Journal of Product Innovation Management **20**: 136-148.

Mason, J. (2004). Qualitative Research. CA: Sage Publication, Thousand Oaks.

Mata, F. J., W. L. Fuerst, et al. (1995). "Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis." MIS Quarterly **19**(4): 487-506.

Mathiassen, L. and A. M. Vainio (forthcoming). "Dynamic Capabilities in Small Software Firms: A Sense-and-Respond Approach." IEEE Transactions on Engineering Management.

McGrath, M. E. (1996). Setting the PACE in Product Development: A Guide to Product and Cycle-Time Excellence, Butterworth Heinemann.

McGrath, M. E. (2001). Product Strategy for High-Technology Companies: Accelerating Your Business to Web Speed. New York, McGraw-Hill Companies.

McGrath, M. E. (2004). Next Generation Product Development: How to Increase Productivity, Cut Costs, and reduce Cycle Times, The McGraw-Hill Companies.

Miles, M. B. and A. M. Huberman (1994). Qualitative Data Analysis: An Expanded Sourcebook. Newbury Park, CA, Sage Publications.

Nahapiet, J. and S. Ghoshal (1998). "Social Capital, Intellectual Capital, and the Organizational Advantage." Academy of Management Review **23**(2): 242-266.

Nambisan, S. (2001). "Why Service Business Are Not Product Businesses." MIT Sloan Management Review **42**(4): 72-81.

Nambisan, S. (2002). "Complementary Product Integration by High-Technology Ventures: The Role of Initial Technology Strategy." Management Science **48**(3): 382-398.

Newman, W. S., A. Podgurski, et al. (2000). "Design Lessons for Building Agile Manufacturing Systems." IEEE Transactions on Robotics and Automation **16**: 228-238.

Orlikowski, W. J. (1993). "CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development." MIS Quarterly **17**(3): 309-340.

Orlikowski, W. J. and J. J. Baroudi (1991). "Studying Information Technology in Organizations: Research Approaches and Assumptions." Information Systems Research **2**(1): 1-28.

Oshri, I. and S. Newell (2005). "Component Sharing in Complex Products and Systems: Challenges, Solutions, and Practical Implications." IEEE Transactions on Engineering Management **52**(4): 509-521.

Penrose, E. (1959). The Theory of the Growth of the Firm. Oxford, UK, Blackwell.

Pettigrew, A. (1985). Contextualist Research and the Study of Organizational Change Processes. Research Methods In Information Systems. E. Mumford, R. A. Hirschheim, G. Fitzgerald and T. Wood-Harper. Amsterdam, North Holland**:** 53-78.

Pisano, G. (1994). "Knowledge, Integration, and the Locus of Learning: An Empirical Analysis of Process Development." Stategic Management Journal **Winter Special Issue 15**: 85-100.

Porter, M. E. (1996). "What is Strategy?" Harvard Business Review **74(**6): 61-78.

Quinn, R. E. and J. Rohrbaugh (1983). "A Spatial Model of Effectiveness Criteria: Towards a Competing Values Approach to Organizational Analysis." Management Science **29**(3): 363-377.

Ramesh, B., J. Pries-Heje, et al. (2002). Internet Software Engineering: A Different Class of Processes. Annals of Software Engineering: Process-based Software Engineering. Y. Wang and A. Bryant. New York, Kluwer Academic Publishers. **14:** 169-195.

Robson, C. (1995). Real World Research. A Resource for Social Scientists and Practioner-Researchers. Oxford, Blackwell.

Sallinen, S. (2002). Development of Industrial Software Supplier Firms in the ICT Cluster: An Analysis of Firm Types, Technological Change and Capability Development. Department of Marketing. Oulu, University of Oulu.

Sambamurthy, V., A. Bharadwaj, et al. (June 2003). "Shaping Agility Through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms." MIS Quarterly **27**(2): 237-263.

Sawyer, S. (2001). "A Market-Based Perspective on Information Systems Development." Communication of the ACM **44**: 97-102.

Sengupta, S. (1998). "Some Approaches to Complementary Product Strategy." Journal of Product Innovation Management **15**: 352-367.

Sharifi, H. and Z. Zhang (2001). "Agile Manufacturing in Practice: Application of a Methodology." International Journal of Operations & Production Management **21**(5/6): 772-794.

Sheramata, W. A. (2002). "Finding and Solving Problems in Software New Product Development." Journal of Product Innovation Management **19**: 144-158.

Sommerville, I. (2001). Software Engineering. U.S., Addison-Wesley.

Sparling, M. (2000). "Lessons Learned Through Six Years of Component-Based Development." Communication of the ACM **43**: 47-53.

Teece, D. J., G. Pisano, et al. (1997). "Dynamic Capabilities and Strategic Management." Strategic Management Journal **18(**7): 509-533.

Truex, D., R. Baskerville, et al. (2000). "A Methodical Systems Development: The Deferred Meaning of Systems Development Methods." Accounting, Management and Information Technologies **10(**1): 53-79.

Tuunanen, T. and A. M. Vainio (2005). "Communication Flows in Software Product Development: A Case Study of Two Mobile Software Firms." JITTA The Journal of Information Technology Theory and Application **7**(3): 2005.

Tyrväinen, P., J. Warsta, et al. (2004). Toimialakehitys Ohjelmistoteollisuuden Vauhdittajana: Uutta Liiketoimintaa Lähialoilta. Teknologiakatsaus 151/2004. Helsinki 2004, Tekes.

Ulrich, K. T. and S. D. Eppinger (2000). Product Design and Development. Boston, The McGraw-Hill Companies, Inc.

Vainio, A. M. (2005). "Exchange and Combination of Knowledge-Based Resources in Network Relationships." European Journal of Marketing **39**(9/10): 1078-1095.

Vainio, A. M., T. Tuunanen, et al. (2004). Developing Software Products for Mobile Markets: Need for Rethinking Development Models and Practices. 38th Hawaii International Conference on System Sciences HICSS-38, Big Island, Hawaii.

Walsham, G. (1993). Interpreting Information Systems in Organizations. Chichester, Wiley & Sons.

van de Ven, A. H. and M. S. Poole (1995). "Explaining Development and Change in Organizations." The Academy of Management Review **20**(3): 510-540.

Wernefelt, B. (1984). "A Resource-Based View of the Firm." Strategic Management Journal **5**: 171-180.

Volberda, H. (1998). Building the Flexible Firm: How to Remain Competitive. New York, Oxford University Press.

Yin, R. K. (1994). Case Study Research: Design and Methods. Thousand Oaks, Sage Publications, Inc.

Zahay, D., A. Griffin, et al. (2004). "Sources, Uses, and Forms of Data in the New Product Development Process." Industrial Marketing Management **33**(7): 657-666.

PART II: ORIGINAL RESEARCH PAPERS

Developing Software Products for Mobile Markets: Need for Rethinking Development Models and Practices

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Developing Software Products for Mobile Markets: Need for Rethinking Development Models and Practices

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Abstract

In the mobile domain, successful software product development requires the incorporation of market elements to the development process in order to gain a wide customer-base for the product. However, the focus of current IS process approaches is on contextual elements and users of the particular customer organization. The existing IS approaches tend to overlook the various views of stakeholders in the market, who have an active role in building, influencing, buying, or using the product. We aim to demonstrate this gap in the IS development processes, especially in the gathering and managing of information concerning the various parties contributing to the market success of a product. Further, we review the market-related New Product Development (NPD) discussion and show that this perspective could offer valuable insights for refining the knowledge and information management of the development process for mobile products.

1 Introduction

The mobile software business is becoming increasingly complex and fast phased. The business is getting more and more networked due to the numerous industry forums, technological coalitions and partnerships. This has an effect on software product development, because the amount and variety of the information of stakeholders who contribute to product success is increasing. In the mobile and wireless markets, as in many other industries[2], the value chain consisting of sequential activities has turned into an integrated, global system that invents value by matching the various capabilities of participants more efficiently and effectively than was ever the case in the past. For a new venture with limited resources, in particular, it is a challenge to collect, analyze, and process the right information and then to integrate it with product development.

In general, IS systems have typically been developed for the needs of a particular organization, while the role of the systems analyst has been to assess business function by examining organizational processes. The objective of analysis and design is to comprehend the operations of an organization as systems [3] and thus the methods suited for that purpose are not, as such, particularly suitable for product development. From the product development perspective, it is important to create sufficient market advantage and to identify the technology that gives the product a wide customer base.

Although end users are assigned by almost all development methods, we argue that there are no procedures for comprehensive information management of process stakeholders in their different roles, not to mention the roles outside of an organization. Wide-audience information systems, such as embedded applications for mobile phones or digital TVs, are emerging, and as Tuunanen [4] presents, this creates new types of development challenges. In these systems, end-users are not within organizational reach [4] and, instead of talking about users and developers, we need to look more widely at the people whose knowledge contributes to the success of the software product. This means identifying the right parties and understanding what knowledge the process needs from them, when they need to be involved, how they relate to each other and how their involvement will affect the success of the product. The increasing amount of information that needs to be processed during product development presents a challenge, which can only be met by establishing structures for dealing with external environment.

Due to the fact that mobile prices are rapidly falling, for example by approximately 46% since 1999 [5], wireless and mobile devices are becoming increasingly standardized commodity products instead of exclusive high-technology products. Due to these environmental changes, the goals of company strategies are shifting to deliver outstanding products in terms of price, quality, and performance. This shift also stresses the need for effectively integrating the knowledge from various sources, such as the market, customers, users, competitors and regulatory parties, in order to produce cheaper, usable and well-functioning products. To meet these needs, the

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eager business community is asking for lighter and nimbler software development processes that also take into account the business case of new products.

The aim of this study is twofold. First, we aim to demonstrate the gap in the current IS and software engineering development methods in incorporating the information of the stakeholders who contribute to a market success of a product. Second, we review the market-related New Product Development (NPD) literature and study whether this perspective could offer valuable insights for refining the development process for mobile products.

These goals are met by analyzing two commonly used IS process models and comparing them with two NPD ones. We organize our analysis in a framework to understand how the software product specification is developed by these models. Overall, we try to understand how the different stakeholders contribute to product success by studying the way how the information delivered from them is implemented in the process, and how this information is used for the development of product specification. In detail, the four process models are analyzed from the following perspectives: 1) the source of information, illustrating how the information is identified and gathered, 2) the activities, informing how the information is processed and analyzed, and 3) the outcome, describing how the information is distributed during the development cycle. This classification helps us to make comparisons between the different approaches. The results of the analysis show that the NPD perspective offered by the marketing literature could be useful in determining the typical challenges in the mobile markets.

The structure of the paper is as follows. First, we introduce the basic concepts used in the NPD literature and review the most common NPD process models. This is followed by a review of the principal streams of process models proposed by the IS discipline. Then, we demonstrate our framework of the selected methods and discuss the major findings. Finally, the conclusions and future research topics are presented.

2 Review of the NPD literature

In the mobile market, the portion of the product lifecycle during which profits can be earned has become progressively shorter due to rapid technological advances, which has led to a sharp rise of development costs owing to technological and design complexity. Thus, more and more often mobile software products are developed as a family, which helps a firm to reduce the cost of developing individual product variants thanks to the reuse of a common product platform. This means that the collection of common elements, particularly the underlying technology elements, is implemented across a range of products [6]. This allows desired individual features and application functions to be configured for specific products [6].

The usefulness of the platform-based product design approach depends on the ability of the firm to convert the effort invested in developing the platform into reduced cost of developing individual variants. In addition to investments, creating a platform requires resources to define an appropriate architecture for the product, upon which a range of products can be developed and with which a large enough market size can be achieved.

Contrary to the service business, the success of a product company lies in its ability to abstract the knowledge obtained during product development. Context specific elements, which are important in services business, must be removed, so that the final product can be deployed in varied situations. Furthermore, higher marginal returns can only be expected from increases in market share because of the predominance of fixed development costs. Users are a critical source of innovation for product vendors, who commit considerable resources to long-term relationships while in service business the relationships tend to be project-driven and dominated by short-term goals [6, 7]. Among other factors, these arguments led us to look for answers to the

Figure 1 The Stage Gate model, modified from [1].

challenges of software product development by studying the marketing-related New Product Development (NPD) discussion.

In line with Chiesa et al. [8], the New Product Development for this study is defined as a set of activities that transform new product ideas into new product designs. The NPD system encompasses the NPD process, and the management and support of this process; the technologies incorporated in people and resources or means needed to carry out these processes; and the organizational arrangements used to divide and co-ordinate the processes. It is an open system, interacting with its internal and external environment through its inputs, outputs and resources.

In NPD management, an important theme is the central role that NPD can play in the primary processes of technology-based companies. The adoption of NPD can speed up time to market, improve product quality as well as increase development efficiency, build core competence, and increase innovative ability [e.g. 9]. Based on the survey of experiences of 120 R&D directors, Gupta and Wilemon [9] found that the major challenges the NPD is currently encountering include monitoring market developments, maintaining a spirit of inquiry while ensuring the performance of R&D, developing technology commercialization capabilities, fostering alliances, and accelerating the development and commercialization of new products.

On the basis of the differences in the competitive environment, Bolwijn and Kumpe [10] distinguish four types of firms as regards specific market demands. In the industries, such as the mobile and wireless, where many companies are able to bring out a continuous stream with a wide variety of cost-efficient high quality products, they [10] suggest that the innovative firm is most successful. They characterize: *"[In the Innovative Firm] cost reduction, quality improvement and increasing flexibility are all embedded in a continuous search for breakthroughs in all areas involved: with the ultimate goal of delivering outstanding products in terms of price, quality and performance"* [10]. Additionally, adaptation in changing environments has become a strategic competence for many organizations [e.g. 11].

Several studies [12-14] also point out that an organization needs to carefully tailor the framework to its own unique context, using the characteristics most appropriate to its industry and strategic priorities. A formal product development process increases information utilization and decision-making effectiveness [8, 15-17] and thus establishes structures necessary for dealing with external environment. Moreover, the activities undertaken in the NPD process incorporate new information to reduce the high uncertainty associated with the volatile mobile environment.

Cooper [18] conducted a study of 58 case histories obtained from industrial product firms. His findings revealed that a well balanced, complete process was likely to yield the best results. According to Cooper [1, 18], this means that the process should involve a wide variety of tasks and activities, and not to be reduced to a few dominant stages. Additionally, key activities such as screening, market research, customer trials, and market launch should not be forgotten in the process. There should also be a balance between market oriented and technical activities.

We chose two examples of generic models for determining the phases of product development: the StageGate model by Cooper [1] and the Generic Development Process presented by Ulrich and Eppinger [19]. In line with the literature [e.g. 20, 21, 22], we suggest that while there are several other model variations available, the selected ones can be considered to be the most suitable for examining the whole NPD process.

Figure 1 illustrates the StageGate model. The process description has been simplified to five stages representing the major events in the NPD process [1]. The stages are cross-functional, thus there is no R&D or marketing stage. Each stage consists of a set of parallel activities undertaken by people from different functional areas in the firm. The players of the project team undertake key tasks to gather information needed to advance the project to the next gate or decision point. The gates between stages serve as quality-control checkpoints. To manage risks via the StageGate method, the activities in a given stage must be designed to gather vital information – technical, financial, and regarding operations – in order to drive down the technical and business risk. The plan is based on incremental commitments, as each stage costs more than the previous one. The gates also have a common format which includes deliverables, criteria and outputs.

According to Ulrich and Eppinger, the typical phases of generic product development are [19]: Planning - Concept Development – System-Level Design – Detailed Design – Testing and Refinement – and Production Ramp-up. The authors illustrate the development process as an information-processing system. The process begins with inputs such as corporative objectives and the capabilities of available technologies, product platforms, and production systems. Various activities process the development information, formulating specifications, concepts, and design details. The process concludes when all the information required to support production and sales has been created and communicated.

The process model by Ulrich and Eppinger identifies the different functions of the organization, such as marketing, design, and manufacturing, during each development phase. The model also calls for tremendous

integration across the functions on the development team. The front-end process of concept development, in particular, requires more coordination among functions than any other phase. The authors [19] also specify that the development process employed by a particular firm may differ from the generic one considered the most appropriate for market-pull products. Products, such as technology-push products, require variants of the generic process that may involve matching technology with a market opportunity and integrating the product to an already existing and proven platform [19].

3 Development Methods in the IS

In the IS development discipline, process development has been moving on a timeline from disorganized ways of working towards more organized ones. A shift from sequential plan-driven process models to flexible agile ones is also evident [23]. In the following, we look into the methods considered the most suitable for the development of mobile software products.

The first published model – the 'waterfall model' – for software development was derived from other engineering processes [24]. It is a systematic, sequential approach, in which each stage requires well-defined input, and results in well-defined outcomes. The IS product is not delivered until the whole linear sequence has been completed. Royce [24] suggests repeating this linear sequence at least twice. The problems related to this linear model are stagnant requirements and badly structured programming. In an attempt to avoid the problem overlapping was implemented between the stages [25]. However, the linear method has been argued to be too mechanistic for detailed practical use [26] and merely idealistic providing only normative guidance for utopian development situations [27]. Thus, it can be argued that the model is not optimized for the mobile environment where requirement changes are occurring at a rapid pace.

In contrast to the waterfall model, an evolutionary approach to software development is often more effective in producing systems that meet the immediate needs of customers. The specifications are developed incrementally and reflect users' understanding of software problems [28]. In the evolutionary approach, reuse is often seen as essential for rapid system development. Furthermore, there is a need to support this kind of process iteration where parts of the process are repeated as system requirements evolve. The models for this purpose comprise incremental development and spiral development. In incremental development, software is developed in small but usable units, which can be delivered to the customer. Each increment is an operative subset of the system and builds on the increments that have already been made [29]. Detailed design, coding, and testing occur within these separate stages [30]. The process of development, validation and integration continues until the delivered increments form a complete product [31].

The Rational Unified Process (RUP) developed by Kruchten, Jacobsen and other at Rational Corporation to complement UML is a good example of the iterative and incremental models. This popular model for object-oriented systems scales from large projects to smaller and lighter ones [32]. RUP can take different aspects varying from traditional plan-driven approaches to new agile ones depending on project characteristics. Unlike most of the other traditional software process descriptions, RUP places high emphasis on the business context of the project. Whether the software is produced for a given customer, to be put on the market or to be developed for an internal customer, the business modeling done during the inception and elaboration phases can be adjusted according to the purpose for which the software is built [32].

The RUP process can be approached from two different and integrated perspectives: 1) a management perspective, dealing with financial, strategic, commercial, and human aspects; and 2) a technical perspective, dealing with quality, engineering and design method aspects. Both of these contribute to a common set of products and artifacts that evolve over time and constitute the milestones of development. As seen from the management perspective, the software life-cycle is organized along four main phases: inception, elaboration, construction, and transition. From the technical perspective, the phases are split into iterations, each having the purpose of producing an executable product which may be a subset of the complete vision.

Extreme Programming (XP) is one of several agile software development methods that have emerged in the past few years. XP was first introduced in [33] and can be seen to provide a particular fit to the volatile mobile and wireless industries. Agile methods challenge the traditional models alleged to be too mechanistic and try to approach the software development with values such as: individuals and human interactions over processes and tools, working software over comprehensive documentation, intense customer collaboration over contract negotiation, and responding to change over following a plan [34]. According to Highsmith and Cockburn [35], agile methods recognize people as the primary drivers of project success, coupled with an intense focus on effectiveness and maneuverability. The core of agile software development methods is defined as the use of light-but-sufficient rules of project behavior and the use of human- and communication-oriented rules [36].

The XP method focuses on delivering immediate business value to the customer. The process can be

characterized by short development cycles, incremental planning, evolutionary design, and its ability to response to changing business needs. The process is divided into several phases: exploration, planning, implementation, productionizing, maintenance and death [37]. The method itself is built around what appears to be an easy-to-understand set of practices, which have been fairly well documented in the literature [37, 38]. These practices are planning game, small releases, metaphor, simple design, testing (test-driven development), refactoring, pair programming, collective ownership, continuous integration, 40-hour work week (also known as sustainable pace) and on-site customer, just rules and open workspace. In addition, spikes [38] are also often associated to the practices of the XP method .

The XP method is designed to meet the needs of a skilled small, i.e. less than 10 developers, team working in a co-located office together with the customer, developing software that is not safety-critical, employing an object-oriented technology [37, 39]. This type of situation is what can be called the ideal setting for the XP method or what Boehm [40] calls 'agile home ground'.

Finally, open source development (OSS) is worth mentioning because it bears some similarity to the agile software development approaches. However, there are still several open questions regarding the stabilization and commercialization of the code to application level. Thus, the OSS is not included in our analysis.

4 Comparison of the models

4.1 Analysis framework

Based on the literature review, four process models were chosen for the basis of comparison. These models are GDP [19], StageGate [1], RUP [32] and the XP method. The models are illustrative examples of the main trends of both the NPD and the IS research streams, respectively. We also gave priority on the suitability of the different models for developing mobile and wireless products and services.

The comparison is organized on the basis of method life-cycle coverage [e.g. 41]. Software product development life-cycle is a sequence of processes employed by an organization to conceive, design, and commercialize a software product [42]. The life-cycle perspective is needed for determining which phases of the development process are covered by the studied methods. In our study, product development life-cycle can be seen as consisting of four overlapping phases [42]: 1) Evaluation; 2) Planning & Concept specification; 3) Development & Testing; and 4) Product release.

Apart from the model-specific practices, we place emphasis on analyzing how the methods support abstracting internal and external knowledge obtained throughout the whole product development process. In particular, we aim at recognizing:

- the source of information, while illustrating how the information is identified and from where it is gathered,
- the activities, while informing how the information is processed and analyzed, and
- the likely output of a stage in light of information about how the information is distributed during the development cycle.

To begin with, the source of information is classified according to three information types, ranging from those internally developed to those obtained from sources external to the firm [43]:

- Internally developed information: strategic; financial; project management (I)
- Internally and externally developed: customer; needs; technical (IE)
- Externally available: competitor, regulatory (E)

Further, the nature of the activities and the output are defined as either marketing-oriented or technology-oriented. Marketing-oriented activities and outputs are identified with the character 'M', while technology-oriented activities and outputs are marked with 'T'.

This classification enables us to identify how the information delivered from different sources is implemented in the process and how the information is used for the development of product specification. It can be argued that by studying how the different parties involved contribute to the different development process phases and how the information processing practices of the methods are used to produce a product specification, we will be able to create novel insights into software product development.

In this study, stakeholders are parties who have an interest in the product, while also having some demands on the product, and who, therefore, have to be consulted in the requirements gathering process. If the stakeholders in a project do not or cannot accommodate their concerns to the concerns of the product, then the project will likely fail. Generally, identifying the stakeholders is important, but our focus is more on understanding how they relate to the success of the project.

4.2 Results of the Analysis

The results of the comparison are presented in Appendix: Table 2. The percentages regarding the nature of activities and outputs (i.e. marketing-oriented / technology-oriented) during the life-cycle of product development are summarized in Table 1. Table 1 highlights, as was expected, that the nature of the activities and outputs in the NPD models is predominantly marketing-oriented, while the IS models focus more on development technology.

Table 1. The nature of activities and outputs (M/T%).

	GDP	SG	RUP	XP
Evaluation	100 / 0	100 / 0	13 / 87	10 / 90
Planning & Concept specification	62 / 38	86 / 14	7 / 93	0 / 100
Development & Testing	56 / 44	46 / 54	14 / 86	6 / 94
Product Release	50 / 50	75 / 25	33 / 67	13 / 87
TOTAL	60 / 40	69 / 31	19 / 81	5 / 95

There are no major differences between the sources of information in the different models. However, although the RUP and XP methods gather the information from customers and end-users rather like the two NDP approaches, the information is processed mainly from the technological perspective. Furthermore, the outputs of the different phases of RUP and XP consist of technological iterations of the prototype with data concerning functionality, domain analysis, architecture, and project plan.

In the IS models, the marketing-oriented activities and outputs dominate only at the beginning and at the end of the process. In RUP, the business case analysis is produced in the inception phase, but it is not refined during the process. After the construction phase, a product is just rolled out to the marketing department with a deployment plan and end-user support material. Further, the XP method fails to give any recommendations for business case analysis or product commercialization, rather the emphasis is on an immediate delivery of technological components to the customer. Quite contrastingly, in the NPD models business case analysis and product definition are iteratively refined during the process.

A further difference can be found in requirements collection; while NPD processes focus on customers paying for the development of the product, IS methods concentrate on users using the product. Further, the focus of the NPD method is clearly on the product, whereas the IS approach primarily discusses the project and the construction of software functionality. Both GDP and StageGate produce a product definition, whereas only RUP assigns 'an evaluation criteria for the final product'.

It should be noted, however, that customers and users, the two stakeholders, have completely different reasons for having a stake in a project; the studied NPD processes focus more on the price while the IS methods stress the usability of products. Overall, among the IS methods, only RUP assigned some moderate marketing-oriented field tests with the customers at the end of the process. The XP method performed just functional testing and performance evaluation.

5 Discussion

This study aims at 1) demonstrating the shortcomings of the current IS and software engineering development methods in taking into account the information regarding the stakeholders contributing to the market success of mobile products and 2) to review the market-related New Product Development (NPD) discussion in order to investigate whether this perspective could offer valuable insights for refining the development process for mobile products.

Firstly, the results of the study indicate that the IS process literature views the relationships with users as transaction-oriented and based on specific projects. However, these established relational mechanisms facilitate only limited information sharing. Although leveraging internal expertise provides time and cost advantages, a company can fail to incorporate market elements into product development without continuously refining the business case through external network relationships. On the other hand, the product sector calls for relationships that can support the sharing and generating of knowledge [7]. Companies can, for example, keep external stakeholders interested by establishing several mechanisms and/or offering incentives and services. Internal connections are also important for promoting knowledge sharing and generating new ideas across project groups.

Secondly, the NPD processes are clearly more marketing-oriented, and take into account, for example, regulatory issues such as IPRs. As opposed to the IS methods, the abstraction of information places more importance on the market and customers than on context specific organizations or users. The emphasis of the IS models is often on usability and decreasing technological risks. From the IS perspective, the recognized risk categories are project risks affecting project schedule and resources, and those affecting the technological quality or performance of the software application being developed. Furthermore, the two NPD processes clearly produce more diversified knowledge before and especially during the development, which is in line with the respective literature [1, 44, 45]. The amount of information processed is also larger as it includes data from various functional departments.

It appears that the identification, analysis and production of information necessary for building a business case is not incorporated as such into the IS development models. Hence, an integration of the NPD approach with software product development is beneficial, or virtually essential.

The analysis also shows that the literature on IS and NPD has mainly been focusing on the interactions between R&D, marketing and manufacturing functions [e.g. 13, 46, 47-49] and has had limited success in explaining the nature of interaction as a whole because of the linearity of the models and the incomplete view of the role of information in integration. For example, very little is said about the integration of other parties in the process. External networks are based on exchange among various firms whose aim is to pool resources and competencies [50]. Thus, the focal company should look more widely at the parties whose knowledge is likely to contribute to the success of the product. In order to stimulate this kind of feedback, the producers need to provide a feedback mechanism that is appropriate for the stakeholders involved in the process.

6 Conclusion

This paper has maintained that producing successful software products for mobile mass markets requires an incorporation of market elements into the development process.

On the basis of the literature review and the comparison of the four development models, we can initially argue that the IS approaches for mobile products fail to incorporate market elements into the development process. We also suggest that NPD-related discussion provides the IS discipline with valuable insights to software product development. The objective of NPD systems is to create new, successful product designs, while IS processes aim to analyze, design, and implement improvements in the functioning of businesses. The former focuses on the information about business objectives, customers, competitive environment and on the alignment with internal functions, while the latter is strongly based on the knowledge of how IS and the latest technological developments can be used for the benefit of the customer. Additionally, because of the special nature of developing mobile software products for mass markets, there is a need to justify the innovation process stage decision through a continuously evolving discourse of the various parties involved. Through this approach, the accumulated information can be used to decrease both technical and business risks.

The results of this study are currently being empirically evaluated in a firm developing mobile products.

Another interesting aspect that requires further investigation is concerned with whether the knowledge management capabilities can be used for distinguishing firms with a lesser success potential. The target of this line of questioning should be identifying the optimal level of information use in relation with the success of respective software products.

7 References

[1] R. Cooper, "Winning with New Products Doing it Right," *IVEY Business Journal*, vol. July-August 2000, pp. 54-60, 2000.

[2] A. J. Campbell and D. T. Wilson, "Managed Networks: Creating Strategic Advantage," in *Networks in Marketing*, D. Iacobucci, Ed. London: SAGE Publications, 1996, pp. 125-143.

[3] K. E. Kendall and J. E. Kendall, *Systems Analysis and Design*. New Jersey: Prentice Hall, 2002.

[4] T. Tuunanen, "A New Perspective on Requirements Elicitation Methods," *JITTA The Journal of Information Technology Theory and Application*, vol. 5, pp. 45-72, 2003.

[5] OFTEL, "Mobile Price Trends," Office of Telecommunications October 2003.

[6] M. E. McGrath, *Product Strategy for High-Technology Companies: Accelerating Your Business to Web Speed*, 2nd ed. New York: McGraw-Hill Companies, 2001.

[7] S. Nambisan, "Why Service Business Are Not Product Businesses," *MIT Sloan Management Review*, vol. 42, pp. 72-81, 2001.

[8] V. Chiesa, P. Coughlan, and C. A. Voss, "Development of a Technical Innovation Audit," *Journal of Product Innovation Management*, vol. 13, pp. 105-136, 1996.

[9] A. K. Gupta and D. Wilemon, "Changing Patterns in Industrial R&D Management," *Journal of Product Innovation Management*, vol. 13, pp. 497-511, 1996.

[10] P. T. Bolwijn and T. Kumpe, "Manufacturing in the 1990s - Productivity, Flexibility and Innovation," *Long Range Planning*, vol. 23, pp. 44-57, 1990.

[11] K. M. Eisenhardt and B. N. Tabrizi, "Accelerating Adaptive Processes: Product Innovation in the Global Computer Industry," *Administrative Science Quarterly*, vol. 40, pp. 84-110, 1995.

[12] P. S. Adler, D. W. McDonald, and F. MacDonald, "Strategic Management of Technical Functions," *Sloan Management Review*, vol. 33, pp. 19-37, 1992.

[13] R. Calantone, C. Droge, and S. Vickery, "Investigating the manufacturing-marketing interface in new product development: does context affect the strength of relationships?," *Journal of Operations Management*, vol. 20, pp. 273-287, 2002.

[14] R. J. Calantone, J. B. Schmidt, and C. A. Di Benedetto, "New Product Activities and Performance: The Moderating Role of Environmental Hostility," *Journal of Product Innovation Management*, vol. 14, pp. 179-189, 1997.

[15] A. De Maio, R. Verganti, and M. Corso, "A Multi-Project Management Framework for New Product Development," *European Journal of Operational Research*, vol. 78, pp. 178-191, 1994.

[16] S. J. Hart and M. J. Baker, "The Multiple Convergent Processing Model of New Product Development," *International Marketing Review*, vol. 11, pp. 77-92, 1994.

[17] K. B. Clark and S. C. Wheelwright, *Managing New Product and Process Development: Text and Cases*. New York: The Free Press, 1993.

[18] R. Cooper, "The New Product Process: An Empirically-Based Classification Scheme," *R&D Management*, vol. 13, pp. 1-13, 1983.
[19] K. T. Ulrich and S. D. Eppinger, *Product Design and Development*. Boston: The McGraw-Hill Companies, Inc., 2000.
[20] T. Ambler and C. Styles, "Brand Development Versus New Product Development: Toward a Process Model of Extension Decisions," *Journal of Product & Brand Management*, vol. 6, pp. 222-234, 1997.
[21] S. Haag, M. K. Raja, and L. L. Schkade, "Quality Function Deployment Usage in Software Development," *Communications of the Acm*, vol. 39, 1996.
[22] A. Griffin and J. R. Hauser, "Integrating R&D and Marketing: A Review and Analysis of the Literature," *Journal of Product Innovation Management*, vol. 13, pp. 191-215, 1996.
[23] B. Boehm and R. Turner, *Balancing Agility and Dicipline: A Guide for the Perplexed*. Boston: Addison-Wesley, 2004.
[24] W. W. Royce, "Managing the development of large software systems: concepts and techniques," *Proc. IEEE WESTCON*, pp. (Ch. 3), 1970.
[25] B. Boehm, "A Spiral model of software development and enhancement," *IEEE Computer*, vol. 21, pp. 61-72, 1988.
[26] J. Nandhakumar and J. Avison, "The Fiction of Methodological Development: A Field Study of Information Systems Development," *Information Technology & People*, vol. 12, pp. 176-191, 1999.
[27] D. Truex, R. Baskerville, and J. Travis, "A Methodical Systems Development: The Deferred Meaning of Systems Development Methods," *Accounting, Management and Information Technologies*, vol. 10, pp. 53-79, 2000.
[28] I. Sommerville, "Software Engineering," 6th ed: Addison-Wesley, 2001.
[29] R. Pressman, *Software engineering -a practitioners approach*: McGraw-Hill, 2000.
[30] S. McConnell, "Rapid Development-Taming wild software schedules." Redmond (WA): Microsoft Press, 1986.
[31] C. M. U. Software Engineering Institute, *Capability Maturity Model Integration (CMMI), Version 1.1, Staged Representation*. Pittsburgh: Addison-Wesley, 2002.
[32] P. Kruchten, "A Rational Development Process," *Crosstalk*, vol. 9, pp. 11-16, 1996.
[33] K. Beck, "Embracing Change with Extreme Programming," *IEEE Computer*, vol. 32, pp. 70-77, 1999.
[34] http://www.agilemanifesto.org.
[35] J. Highsmith and A. Cockburn, "Agile Software Development: The Business of Innovation," *Computer*, vol. 34, pp. 120-122, 2001.
[36] A. Cockburn, *Agile Software Development*. Boston: Addison-Wesley, 2002.
[37] K. Beck, *Extreme Programming Explained: Embrace Change*. Reading, MA.: Addison-Wesley Longman Inc., 1999.
[38] R. Jeffries, A. Anderson, and C. Hendrickson, *Extreme Programming Installed*. Upper Saddle River, NJ: Addison-Wesley, 2001.
[39] M. Lippert and S. Roock, "Adapting XP to Complex Application Domains," presented at The 8th European Software Engineering Conference, 2001.
[40] B. Boehm, "Get Ready For the Agile Methods, With Care," *Computer*, vol. 35, pp. 64-69, 2002.
[41] P. Abrahamsson, J. Warsta, M. T. Siponen, and J. Ronkainen, "New Directions on Agile Methods: A Comparative Analysis," presented at International Conference on Software Engineering (ICSE25), Portland, Oregon, 2003.
[42] M. E. McGrath, *Setting the PACE in Product Development: A Guide to Product and Cycle-Time Excellence*: Butterworth Heinemann, 1996.
[43] D. Zahay, A. Griffin, and E. Fredericks, "Sources, Uses, and Forms of Data in the New Product Development Process," *Industrial Marketing Management*, vol. In Press, Uncorrected Proof.
[44] G. Bacon, S. Beckman, D. Mowery, and E. Wilson, "Managing Product Definition in High Technology Industries: A Pilot Study," *California Management Review*, vol. 36, pp. 32-56, 1994.
[45] R. J. Calantone, S. K. Vickery, and C. Droge, "Business Performance and Strategic New Product Development Activities: An Empirical Investigation," *Journal of Product Innovation Management*, vol. 12, pp. 214-223, 1995.
[46] G. Barczak, "New Product Strategy, Structure, Process, and Performance in the Telecommunications Industr," *Journal of Product Innovation Management*, vol. 12, pp. 224, 1995.
[47] R. G. Cooper and E. J. Kleinschmidt, "Winning Businesses in Product Development: The Critical Success Factors," *Journal of Product Innovation Management*, vol. 14, pp. 132, 1997.
[48] A. Gupta, "The R&D-Marketing Interface in High-Technology Firms," *Journal of Product Innovation Management*, vol. 2, pp. 12, 1985.
[49] W. E. Souder, "Managing Relations Between R&D and Marketing in New Product Development," *Journal of Product Innovation Management*, vol. 5, pp. 6-19, 1988.
[50] H. Håkanson and I. Snehota, *Developing Relationships in Business Networks*. London: Routledge, 1995.

Appendix: Table 2. The analysis of the development processes; the approach: T) technology-oriented; M) marketing-oriented

Stage of development	The Generic Development Process [19]	StageGate [1]	Rational Unified Process [32]	Agile, Extreme Programming [33]
Explicit statement of product development strategy, budget allocation	**0. Planning** Sources of Information: Strategic, financial, project management information (I) Assessments of technology development and market objectives (IE)	**0. Discovery Stage** Idea		
Evaluation	Activities: M - Preliminary investigation Output: M - The project mission statement (the target market for the product, business goals, key assumptions, and constrains)	**1. Idea Screen** Sources of Information: Strategic, financial, project management information (I) The market, customers, needs & wants, technical information (IE) Activities: M - Preliminary investigation Output: M - Prelim market assessment; M - Prelim technical assessment; M - Prelim financial & business assessment; M - Action plan for the next stage; Decision to start extensive investigation	**1. Inception** Sources of Information: Strategic, financial, project management information (I) Customers, end-users, other stakeholders of the project, technical information (IE) …in a form of an original vision, a legacy system, an RFP (request for proposal), the previous generation and a list of enhancements, or a conceptual prototype. Activities: T - Identification of the life-cycle objectives of the project. Output: M/T - An initial business case identifying scope and boundary conditions and acceptance criteria of the project; T - An initial domain analysis model identifying the critical use cases for the functionality of the system; T - An initial architecture prototype; Decision to move to the next phase	**1. Exploration** Sources of Information: Project management information (I) Customers, end-users, technical information (IE) Activities: M/T - The customers write out the story cards that they wish to be included in the first release. Each story card describes a feature to be added into the product. T - The technology team familiarize themselves with the tools, technology and practices of the project. Output: T - A prototype of the system; T - An initial metaphor (i.e. domain-model) for the system; T - An initial set of customer written stories depicting the system functionality
Planning & Concept Specification	**1. Concept Development** Sources of Information: Strategic, financial and project management information (I) Customers, lead users, competitors, competitive products, technology (IE) Regulatory information (E) Activities: M/T - Feasibility of product concepts; T - Industrial design; T - Build and test experimental prototypes; M - Estimate costs; M/T - Production feasibility; M - Investigation of IPR; M - Economical analysis; Output: M - A concept describes the form, function, and features of a product and is accompanied by a set of specifications, an analysis of competitive products, and an economic justification of the project.	**2. Second Screen** Sources of Information: Strategic, financial and project management information (I) Customers, users, competitors, technological information (IE) Regulatory information (E) Activities: M - Detailed investigation Output: M/T - User needs & wants study; M - Competitive analysis; M - Value proposition defined; M/T - Technical feasibility assessment; M - Product Definition M - Financial Analysis Decision to develop if the business case is verified sound	**2. Elaboration** Sources of Information: Strategic, financial and project management information (I) Customers, end-users, technical information (IE) Regulatory information (E) Activities: T - Analysis of the problem domain; T - Define, validate and baseline the architecture; T - Iteration plans for the Construction Output: T - Domain analysis model; T - Detailed software development plan (containing e.g. an updated risk assessment, a project plan, a test plan); T - Software architecture document; M/T - Evaluation criteria for the final product; Decision to build the product	**2. Planning** Sources of information: Developers, project management information (I) Customers, end-users, technical information (IE) Activities: T - Setting the priority order for the stories; T - Making an agreement of the contents of the first small release; T - Estimating the schedule for an each story Output: T - A prioritized list of functionalities (subject to change); T - The project schedule; T - Contents of the first release **3. Iterations to release (implementation)** Sources of information: Developers, project management information (I) Customers, technical information (IE) Activities: T - Manage resources and control process; T - Develop and test components and application features; T - Assess the iteration; …performed with the practices such as writing tests along with the code, refactoring, pair programming, continuous integration, collective ownership, simple design and coding standards. Output: T - Several intermediate in-house system releases (i.e., iterations); T - Testing documentation

Development & Testing	**2. System-Level Design** Sources of Information: Strategic, financial, project management information (I) Technical (IE) Suppliers (E) Activities: T - Definition of the product architecture; T - Decomposition of the product into subsystems and components; M - Plan for product options and extended product family; M - Make-buy analysis Output: M/T - A layout of the product, a functional specification of each of the product's subsystems, and a preliminary process flow diagram for the final assembly **3. Detailed Design** Sources of Info: Project management (I) Technical (IE) Activities: M - Marketing plan T - Technical specifications M/T - Quality assurance M/T - Production plans Output: M/T - The control documentation for the product (the specifications of all functions & components, the process plans for assembly) **4. Testing and refinement** Sources of Information: Financial, strategic, project management information (I) Customers, technical information (IE) Activities: T - Reliability, performance testing; M - Regulatory planning (IPRs); M/T - Refinement of quality assurance; M/T - Delivering prototypes to key customers to be tested in their own environment; M - Sales planning Output: M/T - Confirmation of the performance and reliability of the final product; M - Sales, promotion and launch plans	**3. Development** Sources of Information: Strategic, financial, project management information (I) Customers, users, technical information (IE) Activities: T - Technical development work; T - Developing prototypes; M/T - Collecting initial customer feedback by delivering prototypes; T - In-house product testing; M/T - Operations process development Output: M/T - Rapid prototypes; M - Full launch & operations plans; Decision to move external testing **4. Testing & Validation** Sources of Information: Financial, strategic, project management information (I) Customers, users, technical information(IE) Activities: T - Extended in-house testing; M/T - Customer field trials; M/T - Acquisition of production equipment; M/T - Production/operations trials; M - Test market / test sell Output: M - Finalized launch and operations plans; M/T - Post-launch & life cycle plans; Decision to launch	**3. Construction** Sources of Information: Customers, end-users, technical information (IE) Project management, financial information (I) Activities: T - Manage resources and control process; T - Develop and test components and application features; T - Assess the iteration; Output: T - Components; T - Test beds and test suites; M/T - A deployment plan specifying packaging, pricing, roll out, support, training, transition strategy, production of additional material; M/T - Transition plan	**4. Productionizing** Sources of Information: Project management, developers (I) Customers, end-users, technical information (IE) Activities: T - Testing; T - Performance evaluation; T - Identification of change needs Output: T - Fully functional system (with selected features); T - Evaluation of early output **5. Maintenance** Sources of information: Project management, developers (I) Customers, end-users, technical information (IE) Activities: T - Maintain existing system; M/T - Plan customer support; T - Produce new features Output: T - New releases
Product Release	**5. Production Ram-Up** Sources of Information: Project management (I) Customers (IE) Activities: T - Train engineers and work out any remaining problems in the production; M/T - Delivering products to preferred customers; M/T - Evaluation of early output Output: M - The product launch	**5. Launch** Source of Information: Financial, strategic, project management information (I) Customers (IE) Activities: M - Market launch & roll-out M - Full production/operations M - Selling M/T - Results monitoring Output: M/T - Post-launch & life cycle plans under way; M/T - Internal feedback (How did we do vs. projections? What did we learn?)	**4. Transition** Sources of Information: Financial, strategic, project management information (I) Customers, end-users (IE) Activities: T - Finalize end-user support material; T - Beta testing, piloting in a customer environment, T - Training the users and maintainers of the system; M/T- Release of the product; M - Rolling the product out to marketing, distribution and sales Output: M/T - Updated deployment plan; T - User documentation; M/T - Post-mortem analysis of the performance of the project; M/T - Inventory of the organization's new assets	**6. Death** Sources of information: Project management, developers (I) Customers, end-users, technical information (IE) Activities: M/T - Delivering products to customers (when they no longer have any stories to be implemented); T - Writing documentation of the system Output: T - System and end-user documentation T - Life cycle plans for the system under way

Communication Flows between Product and Software Development Processes: A Case Study of Two Mobile Software Companies

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COMMUNICATION FLOWS IN SOFTWARE PRODUCT DEVELOPMENT: A CASE STUDY OF TWO MOBILE SOFTWARE FIRMS

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ABSTRACT

After a steady rise in the revenue that they achieved in the late 1990s, small software firms, in particular, were hit hard. Because of the restricted investments and tight budgets, the goals of firm strategies started shifting towards delivering outstanding products in terms of price, quality and performance. However, the focus of current information systems (IS) development methods is on improving processes to produce better and more predictable results, and, therefore, they tend to lack responsiveness to market opportunities. In this study, we review the marketing-related discussion of new product development (NPD), and suggest that the NPD framework offers valuable insights for the development of mobile software products. The NPD framework especially contributes to interactions with other business dimensions and the firm's environment. In an interpretive case study of two mobile software firms, we apply both the NPD approach and the IS development methods as a lenses to identify the participants involved in the development of software products, and how the information was communicated between them throughout the phases of software product development. In the two firms, the applied framework uncovered the communication flows between the participants of software product development and integrated the interaction between them into a coherent view. In particular, the findings indicate the importance of informal, tacit communication as a basis for these interactions. As a result of this study, a preliminary conceptual model is presented describing the integration of the NPD approach with the IS development methods through cross-functional teams and rich communication in the development of software products. As a contribution, we suggest that the

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integration of the marketing-related NPD framework with the IS development methods provides guidance for managers to develop successful mobile software products in the dynamic markets in which small software firms exist.

INTRODUCTION

Mobile devices are increasingly becoming standardized commodity products instead of exclusive high-technology products due to the falling retail and service prices. Thus, the firms operating in the field have started to look more closely at their software product development and to look for means that would yield more new outstanding quality products for less investment. This shift also stresses the need for effectively integrating the knowledge from various sources, such as the market, customers, users, competitors and regulatory parties, in order to enhance the market responsiveness of their products. We present that there is a need for integrating more information from the markets to the development of mobile software products.

The information systems (IS) literature has been viewing the relationships with customers and users as transaction-oriented and based on specific organizational projects. Several of the early approaches to IS development methods, like the Waterfall (Royce 1970), suggest that the user needs be collected at the beginning by the analysts. Although researchers have suggested some more iterative methods of development (e.g. Boehm 1988), the linear way of thinking is still quite dominant in the current ways of collecting software requirements (Mathiassen, Saarinen, Tuunanen and Rossi 2004). Among IS development methods, incorporating market elements into the process has proven especially difficult (Regnell, Hösta, Dag, Beremark and Hjelm 2001), as the current views tend to overlook up-front business planning (Vainio, Tuunanen

CONTRIBUTION

This paper makes a contribution to the information systems (IS) research of development methods. The focus of current IS development methods is on improving processes to produce better and more predictable results, and, therefore, they tend to lack responsiveness to market opportunities. The marketing-related discussion of new product development (NPD) provides valuable insights for the development of mobile software products as it especially contributes to interactions with other business dimensions and the firm's environment. This study is the first one to attempt to introduce market elements into the design of development of software products. Further, we consider the NPD concepts and processes as a way of bridging the gap between what is currently done in software development and what we believe needs to be done. The empirical evidence of this study demonstrates how the different participants were involved in the development, and how they communicate throughout the phases of software product development. In both studied firms, the integration of the NPD with the IS development methods helped us integrate important communication flows of software product development into a coherent view. In particular, the study points out the importance of informal, tacit communication between the participants as a basis for these relationships. As a synthesis of our findings, we present the conceptual model of software product development. This model contributes to gaining better understanding of how different participants relate to the market success of a software product and helps manage these relationships.

This study is expected to be very interesting both to researchers and practitioners. For researchers our study opens up the problematic of the integration of marketing with software development. Furthermore, our study can be of interest to IS researchers focusing on agile development methods as we approach organizational agility from the marketing-related perspective yet staying in the software field. Finally, the studies findings provide guidance for practitioners to assess and develop more market-oriented software products in contemporary dynamic environments.

and Abrahamsson 2004).

Within marketing science, the problem of developing innovative new products has led to the birth of a new specific discipline, called "new product development" (NPD), which focuses on delivering a product from idea to launch. The NPD literature presents that customers and users are important sources of innovation and firms are therefore encouraged to commit considerable resources to build sustainable, long-term relationships to them. Researchers have especially stressed the importance of listening and responding systematically to the voice of the customer (Cooper 2000; Hauser 1988; Zahay, Griffin and Fredericks 2004). Furthermore, firms need to understand their external environment and integrate this knowledge appropriately with their knowledge domain. Functional integration of marketing and design functions has been said to be one of the key issues for the success of products (Barczak 1995; Gupta 1985; Souder 1988). Similar to the IS research, few researchers have emphasized a well-structured process (Cooper 1990), arguing that by executing an NPD with incremental commitments, firms can minimize the market risk involved.

Basically, software product development can be said to be a knowledge-activity (McGrath 1996). We present that institutionalizing and leveraging knowledge and experience of stakeholders will increase the responsiveness to market opportunities. Communication between stakeholders is likely to be even more important in order to produce market-oriented software products. This need of communication has been widely recognized within the IS field (Keil and Carmel 1995; Tuunanen 2003), but no exact ways of facilitating the information flows during software product development have been proposed. On the other hand, fostering a culture of communication and functional integration provides more flexibility to respond to the dynamic environment (Mata, Fuerst and Barney 1995). In this study, we review the marketing-related discussion of new product development (NPD), and suggest that the NPD framework offers valuable insights for the development of mobile software products. The NPD framework especially contributes to interactions with other business dimensions and the firm's environment.

We used an interpretive case study of two mobile software firms (Klein and Myers 1999; Orlikowski and Baroudi 1991) as a research methodology to demonstrate the integration of the marketing-related NPD development with the IS development methods. By using both the NPD approach and the IS development methods as a lenses we identified the participants involved in the development and how the information is communicated between them during the phases of software product development. The findings address the importance of continuous communication across software product development. We also show that while formal communication proved to travel according to the pre-defined process specifications, the essential information for product development was exchanged in a more informal way. In particular, we identified three main information flows in the development of software products. At those points, teams got meaningful, high-fidelity feedback on the performance of the product and undertook responding to that information. As a synthesis of our findings, a preliminary conceptual model describing these identified communication flows is presented.

The structure of the paper is as follows. Next, we review insights from the IS literature to identify the development methods suitable for mobile products. Then, we review how the NPD discipline has addressed similar issues. As a summary, an assessment of the two approaches is presented to guide our empirical research. This is followed by the design of the interpretive case study. Subsequently, we present two cross-case analyses with a synthesis of the findings. Finally, we discuss the results and present the conclusions.

IS DEVELOPMENT METHODS

In the IS literature, software development methods have evolved from disorganized ways of working towards more organized ones. The 'waterfall model' was one of first ones to emerge to the scene (Royce 1970). The waterfall model is still well-used and it can be described as a systematic, sequential approach, in which each stage requires well-defined input, and results in well-defined outcomes.

The software product is not delivered until the whole linear sequence has been completed. Royce (1970) suggests repeating this linear sequence at least twice. The problems related to this linear model are stagnant requirements and badly structured programming. In an attempt to avoid the problem, overlapping was implemented between the stages (Boehm 1988). However, the linear method has been argued to be too mechanistic (Nandhakumar and Avison 1999) and merely idealistic providing only normative guidance for development situations (Truex, Baskerville and Travis 2000).

In contrast to the waterfall model, an evolutionary approach to software development is often more effective in producing systems that meet the immediate needs of customers. The specifications are developed incrementally, while reflecting the user's understanding of software problems (Boehm 1988). In the evolutionary approach, reuse is often seen as essential for rapid software development. Furthermore, there is a need to support process iteration where parts of the process are repeated as system requirements evolve. Incremental development and spiral development models meet this requirement. In incremental development, software is developed in small but usable units, which can be separately delivered to the customer. Each increment is an operative subset of the system and builds on the increments that have already been made (Pressman 2000). Detailed design, coding, and testing occur within these separate stages (McConnell 1986). The process of development, validation and integration continues until the delivered increments form a complete product.

The rational unified process (RUP) is a contemporary example of iterative and incremental methods. This popular model has been argued to take different aspects varying from traditional plan-driven approaches to new agile ones, e.g. (Merisalo-Rantanen, Tuunanen and Rossi 2005), depending on project characteristics. Unlike many of the traditional software process descriptions, RUP places high emphasis on the business context of the project. Whether the software is produced for a given customer, to be put on the market or to be developed for an internal customer, the business modeling done during the inception and elaboration phases can be adjusted according to the purpose for which the software is built (Kruchten 1996). The RUP process can be approached from two different and integrated perspectives: 1) a management perspective, dealing with financial, strategic, commercial, and human aspects; and 2) a technical perspective, dealing with quality, engineering and design method aspects.

Agile development methods are another approach to the problems concerning understanding users' needs (Abrahamsson 2003; Abrahamsson, Warsta, Siponen and Ronkainen 2003). Extreme programming (XP) is an example of the agile software development methods that have emerged in the past few years. XP was first introduced in (Beck 1999a). Agile methods challenge the traditional models alleged to be too mechanistic, and approaches software development with such values as: individuals and human interactions over processes and tools, working software over comprehensive documentation, intense customer collaboration over contract negotiation, and responding to change over following a plan (Beck, et al. 2001). According to Highsmith and Cockburn (2001), agile methods recognize people as the primary drivers of project success, coupled with an intense focus on effectiveness and maneuverability. The core of agile software development methods is defined as the use of light-but-sufficient rules of project behavior and the use of human- and communication-oriented rules (Cockburn 2002). Researchers have presented that XP is a combination of best practices of more traditional software development methods (Merisalo-Rantanen, Tuunanen and Rossi 2005).

NEW PRODUCT DEVELOPMENT

New product development is generally defined as a set of activities that transform new product ideas into new product designs. The NPD system encompasses the NPD process, the management and support of this process; the technologies incorporated in people and resources or means needed to carry out these processes; and the organizational arrangements used to divide and co-ordinate the processes. It is an open system, interacting with its internal and external environment through its inputs,

outputs and resources (Chiesa, Coughlan and Voss 1996). The adoption of NPD is said to speed up time to market, improve product quality as well as increase development efficiency, build core competence, and increase innovative ability.

Like in the IS literature, NPD researchers have found that a complete, formal product development process potentially enhances the utilization of information and the effectiveness of decision-making (Clark and Wheelwright 1993; De Maio, Verganti and Corso 1994; Hart and Baker 1994). Cooper (1983; 2000), has suggested that this process should involve a wide variety of tasks and activities, rather than be reduced to a few dominant stages. Additionally, such key activities as screening, market research, customer trials, and market launch should not be forgotten in the process. There should also be a balance between market oriented and technical activities. Cooper has elaborated these ideas by presenting a particular development method: the StageGate model (Cooper 2000).

Figure 1 illustrates the StageGate model. The process description has been simplified to five stages representing the major events in the NPD process (Cooper 2000). The stages are cross-functional, thus there is no R&D or marketing stage. Each stage consists of a set of parallel activities undertaken by people from different functional areas in the firm. The players of the project team undertake key tasks to gather information needed to advance the project to the next gate or decision point. The gates between the different stages serve as quality control checkpoints. To manage risks via the StageGate method, the activities in a given stage must be designed to gather vital information – technical, financial, and operation-specific – in order to drive down the technical and business risk. The plan is based on incremental commitments, as each stage costs more than the previous one. The gates also have a common format, which includes deliverables, criteria and outputs.

Another interesting perspective to the NPD methods is the Generic Development Process by Ulrich and Eppinger (2000). According to them, the typical phases of generic product development are: Planning – Concept Development – System-Level Design – Detailed Design – Testing and Refinement – and Production Ramp-up. The authors illustrate the development process as an information-processing system. The process begins with inputs such as corporative objectives and the capabilities of available technologies, product platforms, and production systems. Various activities process the development information, formulating specifications, concepts, and design details. The process concludes when all the information required to support production and sales has been created and communicated. The generic development process model (Ulrich and Eppinger 2000) identifies the different functions of an organization, such as marketing, design, and manufacturing, during each development phase. The model also calls for tremendous integration across the functions of the development team. The front-end process of concept development, in particular, requires more coordination among the functions than any other phase.

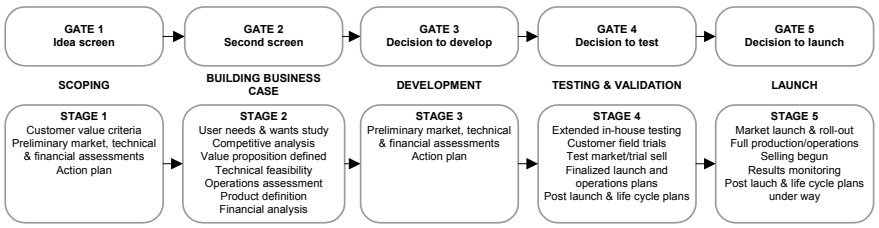

Figure 1. The Stage Gate model, modified from Cooper (2000)

ASSESSMENT FOR SOFTWARE PRODUCT DEVELOPMENT

Although the IS development methods and the NPD ones excel in their own domain areas, there is no a comprehensive view to software product development. In the IS development, the process management focuses on identifying risks and drawing up plans to minimize the effect of risks on the project (Alter and Ginzberg 1978; Davis 1982; McFarlan 1981). The focus is on developing individual products faster with a better process producing more quality and more predictable results. Although the literature specifies several causes for uncertainty in software development (Barki, Rivard and Talbot 1993; Boehm, Clark and al. 1995), the main identified risk categories are project-related, affecting project schedule and resources, and technological, affecting the quality or performance of the software application being developed. From the IS perspective, business risks affect the organization developing the software, which indicates that business risk management is not incorporated as such into the existing software process models. To summarize, it can be suggested that the IS process approach ignores the emphasis on up-front business planning and late-phase product launch preparation, making the software product development unbalanced (Vainio, Tuunanen and Abrahamsson 2004).

In response to the lack of market responsiveness, the NPD literature has provided development methods that attempt to build success into the process by designing stages for gathering the market information needed to lower the business risk (Cooper 2000). Each stage costs more than the previous one, the model is thus being based on incremental commitments. The purpose is to move products from concept to market faster and more efficiently. However, the popular stage-gate approach used in many software companies is rather similar to the linear waterfall process, which can make the accommodation of the newest agile methodologies difficult. This suggests that software firms should require more than just a series of stages. It might be useful to adopt ideas from Boehm (1988), for example, and study if product development processes could be extended to allow for iteration and experimentation.

In software product development, information is clearly a resource that is necessary for development teams. How this information is managed in a firm is important (Zahay, Griffin and Fredericks 2004) and can produce a competitive benefit. Since software development is basically a knowledge-activity (McGrath 1996), we can argue that institutionalizing and leveraging knowledge and experience increases productivity. By encouraging these activities, communication is likely to lead to a greater degree of integration of the various functions in an organization. As (Mata, Fuerst and Barney 1995) summarize, successful companies increase flexibility in their organizations by fostering a culture of communication and functional integration. This need of communication has also been widely recognized within the IS field (Curtis, Kellner and Over 1992; Keil and Carmel 1995), while no exact ways of facilitating the information exchange between marketing and software development have been proposed. We therefore take the reviewed literature as our research lenses and use it to demonstrate and interpret how 1) different participants are involved in the development, and 2) how the information is communicated during the phases of software product development.

RESEARCH METHODOLOGY

This research is designed as a deductive, interpretive case study to explore the development of mobile software products in high velocity markets. Specifically, we apply the NPD development and the IS development methods as a research lenses to identify how the different participants were involved in development of software products, and how the information was communicated between them throughout the phases of software product development. To focus the study more accurately and to help shape the design of the study (Eisenhardt 1989; Klein and Myers 1999), we use the chosen research lenses to create a firmer empirical grounding for drawing implications. We adopt an interpretive approach (Walsham 1993) to study how the participants of the development of software products interact in small mobile software firms. Interpretive studies attempt to

understand phenomena through accessing the meanings that participants assign to them and to explain why members of a social group act the way they do (Klein and Myers 1999; Orlikowski and Baroudi 1991). Therefore, the chosen research methodology is in line with our research objectives.

Case Selection

We use the case study approach (Yin 1994) to understand the dynamics in the development of mobile software products. The approach includes different data collection methods and provides many sources of evidence to help reach a deep understanding of the phenomenon and to ensure satisfactory validity of the findings (Eisenhardt 1989; Yin 1994) . Similar to other studies (Barley 1986; Heaton 1998; Orlikowski 1993), our case selection was based on the theoretical sampling to obtain information from comparable cases (Glaser and Strauss 1967; Orlikowski 1993). Replication adds confidence and robustness to the findings, but it does not ensure generalizable results (Miles and Huberman 1994; Yin 1994). We selected two small, Finnish software firms that both seek high growth based on initial venture capitalists' investments. The two firms operate in similar contexts and have similar goals, but they are in different stages of business development. Thus, the firms were selected for their similarities as well as their differences.

The identified two firms are competent in responding to the market opportunities with their mobile software products. From 1999 to 2003, their turnover has increased steadily. Also, the number of customer accounts, the size of the organization, and investor funding increased yearly in both firms. These indicators suggest that both firms were capable of developing successful software products. The selection strategy used thus ensured that the firms were being worthy of examination in this study. Equally, we wanted two firms on different stages of business development. The literature suggests that the maturity of a firm affects its development practices (Dove 2001; Greiner 1998). One firm, *Multimedia,* is a recent start-up, and the other, *Messaging*, is a mature, but still small software firm. As a result, the two firms differ on dimensions such as size, available resources, management and culture. These differences in organizational conditions allowed us to make contrasting interpretations during data analysis.

Data Collection

To ensure rich data from the two firms and to facilitate triangulation, we collected evidence from four sources within each firm (Yin 1994). *First*, we acquired written material including brochures, annual reports, internal documents, and trade journal articles about the firms. *Second*, we used archives such as marketing presentations, organizational records, project documentation, and customer records. In doing so, we kept in mind that the documents stated the interpretations of actions in the firms rather than unmitigated truth (Yin 1994). *Third*, we used observation through site visits. One of the authors visited both firms three times and made observations of meetings, locations of work activities, and normal office communications. These observations provided valuable information about organizational arrangements and practices. *Fourth*, we conducted theme interviews of three types in each firm as the use of multiple respondents enhances the creative potential of the study and builds confidence in the findings (Eisenhardt 1989).

To begin with, the CEO (at *Multimedia*) and the head of business development (at *Messaging*) gave us details focusing on management, business development, and marketing issues. Subsequently, these key informants suggested managers involved in such practical operations to join for additional interviewing to offer more details. Finally, the head of software development or the head of technology provided us with details concerning software development practices.

In all interviews, the stream of questions was fluid rather than rigid (Rubin and Rubin 1995) and the interviews were of an open-ended nature. However, to ensure sufficient support for exploring our research theme we focused on a certain set of questions derived from the study protocol (Merton, Fiske and Kendall 1990). The interviews were taped and notes were taken simultaneously. The use of multiple sources of evidence allowed us to address a broader range of historical, attitudinal, and behavioral issues. In particular, the two written sources of evidence were

helpful in corroborating and augmenting evidence from other sources. For example, we compared the development process documentation with interview data to verify the effective involvement of participants in software product development. Thus, we were less likely to be misled by single sources and more likely to be critical in interpreting the contents of each source of evidence.

Selected Cases

The two firms selected operate in the mobile markets and both of them have already a number of references in the markets. The firms differ from one another in terms of business development stage; while one – *Multimedia* – is a start-up firm established in 2001 and it has just recently begun to commercialize the first version of a product, the other – *Messaging* – has already launched four product versions during its six financial years. In 2003, the turnover of *Multimedia* was 2.5 million euros and it had 62 employees. The comparable figures for *Messaging* were 5 million euros and 65 employees. In 2003, *Multimedia* was just about to reach breakeven and was estimating its turnover to be five times as high in 2004. Likewise, *Messaging* was estimating its turnover to grow approx. 20 to 30% in the following year. The selected cases were named *Multimedia* and *Messaging* after their product offerings.

Messaging had developed a middleware solution enabling mobile operators to increase their control in the mobile content business by managing the process of provisioning, delivering, and charging for a service portfolio. Multimedia Framework, as the product of *Multimedia* was called, was a complete system incorporating all the technology required for implementing mobile video applications for mobile devices ranging from cellular phones to digital cameras. The customer segments of the two firms consisted of component suppliers, device and phone manufacturers, operators, and service providers.

Data Analysis

The purpose of our data analysis was to identify and evaluate communication flows throughout the development of software products with a particular emphasis on interactions between the participants involved. In a first rough analysis, we studied financial information from 2000 to 2003, future estimates for 2004, strategy and operating plans, organization structure, and product white papers to focus and plan the detailed data collection through interviews and site visits. Then, in line with (Eisenhardt 1989; Miles and Huberman 1994; Yin 1994), we analyzed these detailed data from different perspectives.

First, we conducted an analysis to identify the participants involved in each development phase and the communication flows between them in each firms. In this study, participants are parties who have an interest in the product, while also having some demands on the product, and who, therefore, are to be consulted in the requirements gathering process. Identifying necessary participants is important because if they do not or cannot accommodate their concerns to the concerns of the product, then the product will likely fail. This cross-case analysis was theory-driven (Miles & Huberman 1994) primarily using the NPD approach and the IS development methods as a lenses to study the interactions of the participants and their nature during the phases of development. The quotations for this analysis are presented directly from our field notes (Lee 1989; Orlikowski 1993), see Appendix 1.

Second, we conducted another cross-case analysis to identify the level of intentional involvement for each participant of the development. Again, this analysis was theory-driven using McGrath's notation (1995) to identify the contribution of participants involved. The CEO of each firm was asked to define the level of involvement of participants. The purpose of the analysis was to describe the involvement of participants by objectives in each phase, and study how it corresponds to other field notes and observations.

Finally, the data collected in each firm was used for a detailed analysis in which we formed a conceptual model reflecting the development phases and the connecting links between the phases in both firms. The NPD approach and the IS development literature were employed as a basis for the conceptualization.

The first and the second analyses help to compare and contrast the interactions and their nature across the two firms. Meanwhile, the conceptualization identifies the similarities regarding the development of software products of the firms. Analyzing data on these distinct perspectives helped ensure a good cross-case comparison. In line with (Eisenhardt 1989; Miles and Huberman 1994; Yin 1994), this systematic approach to a priori specification of model made it possible to develop a coherent understanding of communication flows in the development of software products in the two firms.

FINDINGS

In the following sections, the results of the analyses are presented. First, we present the analysis to identify the participants involved in the development of software products and the communication flows between them. Second, we introduce the other cross-case analysis to identify the level of involvement by objectives in each firm. Finally, we synthesize our findings into a preliminary conceptual model describing the communication flows in software product development.

The decision-making of product innovation in both firms turned out to be coordinated on a milestone basis, which resembled the stage-gate product development process (Cooper 1990). However, both firms had adjusted the high level staged process to accommodate the iterative software development practices. These changes involved incorporating iterations into the middle phases of the process, as the implementation and component factory' phase was modified to emphasize a critical exercise of iteration planning. This phase now broke out into series of planned, structured iterations, which reflected a software product's component-based architecture. As regards the IS methods, *Messaging* had adopted the RUP model whereas *Multimedia* relied on extreme programming. In conclusion, we identified five comparable phases in each firm: 1) scoping and requirement elicitation; 2) building business case and requirement analysis; 3) implementation and component factory; 4) testing and validation / product integration and 5) launch.

Table 1 and 2 provide summaries of our analysis to identify the participants involved in each development phase and the nature of their interactions. In particular, we aim at recognizing: 1) the source of information, while illustrating how the information is identified and from where it is gathered, 2) the nature of the information exchange ranging from informal and tacit to formal and explicit, 3) the activities, while informing how the information is processed and analyzed, and 4) the likely output of a phase in light of information about how the information is distributed during the development cycle.

At *Multimedia*, the decision-making was led by the management group including members from all important functions. *Multimedia* was not employing any systematic approach to forecast end-users' needs and desires. Scoping and requirement elicitation was based on the intuition of the management group and some unofficial discussions with few customers and members of technology forums. Therefore, it can be characterized one-way communication. On the other hand, they also discussed a lot with few of their key customers and business acquaintances. However, the management group rarely produced any systematic and explicit output of their decisions in the first phase. Furthermore, the line between the first phase and the second one was very thin and decision-making during both of the phases relied mainly on the management group's work. However, in the second phase, *Multimedia*'s sales team discussed a lot with their key customers, which provided information for making a decision whether to start development. This material consisted of financial analyses, initial technology feasibility assessment, software development plan, and assessment of the architecture.

Implementation and component factory was performed in-house and there were no external functions involved. The output of the phase consisted of prototypes and early versions of a product. After technical development work, software engineers performed extended in-house testing. From testing and validation to the last phase of launch, feedback was gathered only from few potential customers in casual sales meetings. Early versions of the product were used to simulate a product concept for sales support. These prototypes

served salesmen more than software engineers, as the purpose was to conceptualize the product to collect the customer feedback. It was notable that the product documentation and brochures were published later or not at. The findings also indicate how the nature of information exchange between the participants was based only on informal, face-to-face communication during the last phases. At the launch phase, they contacted potential clients without any formal post-development plans. Nothing but a few pieces of information exchanged or produced were explicit, such as occasionally made system documentations.

Table 1. Communication flows at *Multimedia*.

Stages	Information sources	Two-way/ One-way	Nature of information exchange	Activities by participants
Scoping & Requirement Elicitation	Potential customers, partners, technology forums	One-way	Explicit information (news, documents, info archives), implicit information	Preliminary investigation made by the management group
	Customers, partners	Two-way	Tacit knowledge, casual discussions	Feedback collected by the sales team
	Output: A prelim market assessment in the mind of the management group No decisions			
Building Business Case & Requirement Analysis	Employees	Two-way	Tacit knowledge, casual discussions	Ideas collected by the management group
	Key customers	Two-way	Tacit knowledge, structured discussions	Discussions about the product concept by the sales team
	Output: Financial analyses, technical feasibility assessment (not in explicit form), software development plan, software architecture Decision to start development			
Implementation & Component Factory	-			
	Output: Rapid prototypes, components, evaluation of early output Decision to move to external testing			
Testing and Validation & Product Integration	Potential customers	Two-way	Tacit knowledge, structured discussions, prototype, the first versions of a product	Delivering customer field trials The sales team presents the product to potential customers
	Output: Transition plans, fully functional system No formal decisions – gradual transition to launch			
Launch	Potential customers	Two-way	Tacit knowledge, casual discussions Explicit presentation	The sales team presents the product to potential customers
	Output: Occasionally made system documentation			

Table 2. Communication flows at *Messaging*.

Stages	Information source	Two-way/ One-way	Type of information collected or exchanged	Mechanism of collecting information
Scoping &Requirement Elicitation	Potential customers, partners, technology forums	One-way	Explicit information (news, documents, info archives), implicit information	Preliminary investigation made by the management group
	Current customers, partners	Two-way	Tacit knowledge, casual discussions	The sales team is in contact with customers
	Current customers	One-way	Emails, feedback form	Collecting feedback through a digital channel and storing data in a database.
	Key customers	One-way	Structured survey	A market analysis
	Competitors	One-way	Explicit documents	Systematic collection of bids
	Current customers	One-way	Structured survey	A quality survey
	Technology forums, software seminars	Two-way	Tacit knowledge, casual discussions	The product steering group
	Output: Prelim financial & business analyses, technical assessment, initial domain model analysis, action plans for the next phases Decision to start extensive investigation			
Building Business Case & Requirement Analysis	Financial data, market data	Two-way	Explicit analysis	Detailed investigation made by the management group
	Technology forums, competitors	Two-way	Tacit knowledge, informal discussions	Detailed investigation made by the product steering group
	Key customers	Two-way	Casual discussions, early version of a product concept	The sales team collects feedback from customers
	Output: Financial analysis, value proposition defined, competitive analysis, technical feasibility assessment, domain analysis model, software development plan, software architecture Decision to start development			
Implementation & Component Factory	Key customers	Two-way	Prototype	The sales team collects initial customer feedback by delivering prototypes
	Output: Rapid prototypes, components, evaluation of early output Decision to move to external testing			
Testing and Validation & Product Integration	Key customers	Two-way	Tacit knowledge, structured discussions, prototype, the first versions of a product	Customer field trials. The sales team is in contact with customers and starts to sell
	Potential sales partners	Two-way	Tacit knowledge, structured discussions	The head of business development with marketing positions the product in partner network
	Output: Transition plans and operation plans, test beds and test suites, fully functional system No formal decisions – gradual transition to launch			
Launch	Potential customers, partners and members of technology forums	Two-way	Tacit knowledge, casual discussions Explicit presentations	The management, sales and marketing present the product to potential customers
	Current customers	One-way	Structured survey	After sales survey
	Output: Post-launch & life cycle plans under way, internal feedback, system documentation			

Messaging was clearly more systematic and interactive regarding communication. Similar to *Multimedia*, their management group was responsible for leading common decision-making. However, a product steering group produced additional material for technical, software engineering and product feasibility assessments.

At the scoping and requirement elicitation phase, the most of communication at *Messaging* was colloquial discussion between salesmen and customers. The management group and the product steering group processed this information. They also systematically screened various sources, such as customers, network partners, and competitive environment through competitor offers and market follow-up. Customer feedback was formally collected through a digital channel and stored in a database. The responses were given priorities according to three levels and the results were regularly reviewed by the management group and the product steering group. The quality survey was also conducted for current customers yearly. The output of the phase included prelim financial and business analyses, technical assessment, initial domain model analysis and action plans for the next phase. This information was used for making a decision to start extensive investigation.

In the second phase, *Messaging* continued their extensive communication with customers, partners and competitors to test the feasibility of a product concept. The findings were articulated by explicit means. Already at this phase they started profound co-operation with their key customers with the purpose of gathering in-depth feedback of a product concept. As a product got more completed, they were able to test both the functionality and the usability with a few key customers from the business perspective. The co-operation with customers was characterized as relaxed and friendly communication supporting learning activities of both partners. This phase created diverse material to make the next decision to start development.

Similar to the two first phases, the two-way communication with customers was intense in the phase of implementation and component factory. Their sales team collected initial customer feedback by delivering prototypes. The iterative development according to the RUP guidelines continued until a product was considered to be ready for external testing. At the testing and product integration, *Messaging* started systematically contacting potential sales partners to strengthen their market position. The output of this phase consisted of transition and operation plans, test beds and suites, and fully functional system components. This was followed by gradual transition to launch. Finally, at the launch phase, salesmen and the management presented the product to the market and customers in industry fairs. Subsequently, the results of the launch were monitored and used for future development. As opposed to *Multimedia*, *Messaging* invested a lot in introducing their product to potential partners to be able to form a comprehensive offer with them. They believed that relationships with complementarities will increase their initial market reach and accelerate the sales growth. The relationships were mainly based on personal commitments between the partners as there were no official, explicit agreements.

As a summary, this analysis indicates how the quality of information generated during development differed; *Messaging* collected more intensively richer data from the market. Additionally, the information sources were more plentiful and the direction of communication was more two-way. Although both firms provided the response to the information during development, *Messaging* had defined and structured more explicit and formal activities to support the communication and information management. Testing and validation of a product innovation were more intense at *Messaging* because they had the possibility to gather feedback from more parties.

The second analysis presents how the different participants were involved in the development of software products. The analysis was carried out according to McGrath's notation of concurrent engineering. The results are presented in Figure 2 and 3. The purpose of the analysis was to identify an intentional level of involvement of each participant in each of the development phases. The analysis uses three shades of color to distinguish how different parties contributed to

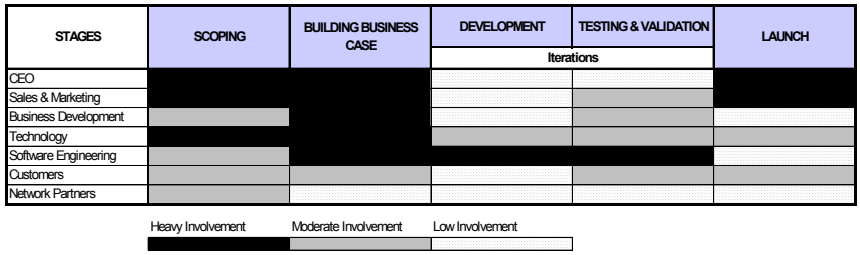

Figure 2. The participants involved in the development of software products at *Multimedia*.

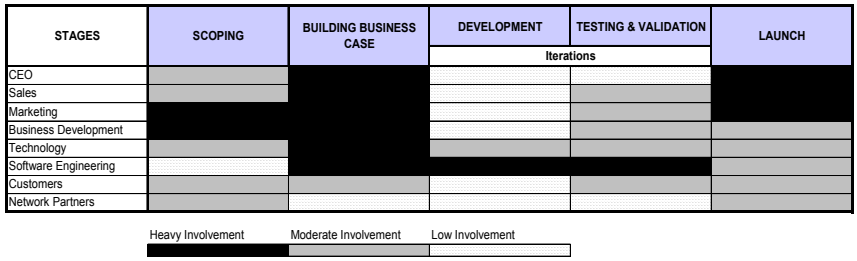

Figure 3. The participants involved in the development of software products at *Messaging*.

the development of software products. On the vertical axis, the potential participants are listed, while the shading indicates the level of involvement for each party at the development phase.

The *Multimedia* CEO couldn't quite well illustrate when and how much each function was involved in the phases of development. They had processed specifications only from the software engineering perspective. Rather, he pointed out the distinct role of the management team to take care of the business, software engineers to develop and salesman to deliver the product to customers. Despite the lack of structure, this close-knit management team was effective in communication and decision-making. However, the management group was heavily involved in up front phases, as this decision-making became irregular in the later phases. There were no coordinated activities to deliver the product to the market. On the contrary, the head of business development of *Messaging* indicated the roles of each participant in the development phases without difficulties. They had detailed process descriptions with the personal accountabilities specifying the outcomes of the phases. After all, concerning both firms, this analysis corresponded well with the first analysis thus corroborating and augmenting evidence of this study.

Conceptual model of software product development

The preliminary conceptual model is illustrated in Figure 4 presenting the phases and the identified communication flows. The model synthesizes our findings so far. The information flows originated in the NPD approach and the IS methods are depicted with solid arrows. These represent a fairly linear flow, where information is enhanced during the process. An exception was the middle part, where the respondents described the implementation and component factory to be iterative. Finally, the process ends with the launch of the product.

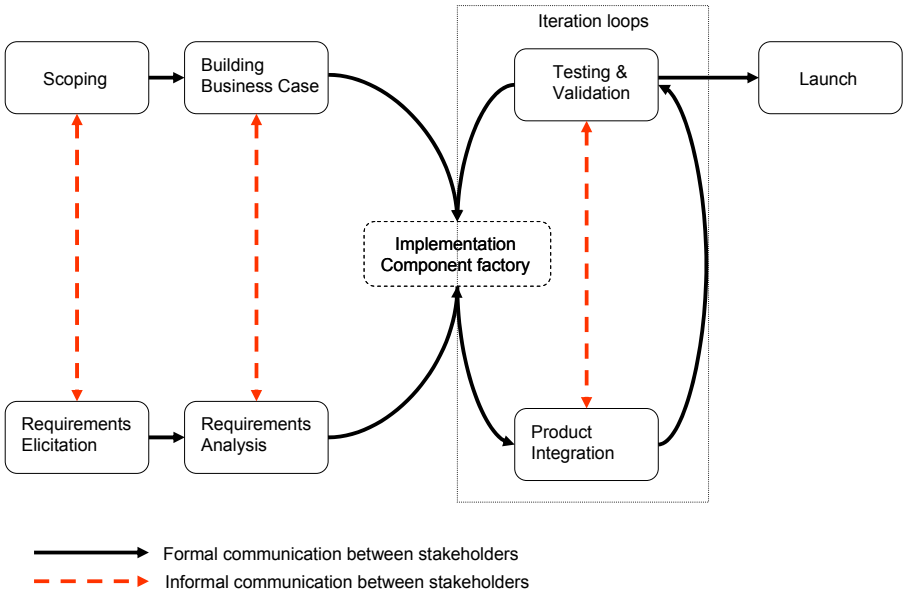

Figure 4. Communication flows in software product development

The four red arrows point out the main communication flows between the two processes. At those points, the teams got meaningful, high-fidelity feedback on the performance of the product and undertook responding to that information. By doing this, the firms identified the main obstacles that needed to work on to get the process to be more flexible. However, it often remained tacit how the information was exchanged between the different participants. Three points in which the participants sensed and responded to changing requirements, are represented by the three dashed arrows.

The first link connected the scoping to the requirements elicitation. In both cases, at this point the necessary information was collected to define "What will be built?" The information such as customer needs and requirements, market development, technology, competitor follow-up and development proposals were gathered trough. These details were gathered mainly in informal discussions. In both firms, the management group confirmed the definitions before moving on to the next stage. At the second point, a software product was aligned with the business strategy. Therefore, all main functions were assigned to verify the business case and look for feedback from their environment. Although *Messaging* committed a somewhat deeper analysis, there were no major differences between the two firms regarding this point. At the third point, the emphasis was on integration. Development and validation activities were carried out concurrently with rapid feedback across these activities. At this point, near final versions of the components of the product were used in both firms as prototypes. As software engineers were correcting some remaining defects, customer trials and test marketing were conducted with the prototypes. Occasionally, the product was introduced to the markets with partners.

DISCUSSION

This study focuses on the development of software products. Our purpose was to demonstrate the integration of the NPD approach with the IS development methods and show its usefulness in developing the responsiveness of software product development to market opportunities.

The findings suggest that development of mobile software products is distinctly divided into two parts, according to how it deals with project risks. We contend that the evolutionary NPD stream, based on the staged approach (McConnell 1986), focuses on managing business risks, whereas the iterative and incremental IS development process places more emphasis on technological risks. However, the two processes were highly intertwined through an informal, intensive and rich communication during development, and through cross-functional teams. The two firms had successfully adjusted the staged product development to accommodate the iterative IS development methods (Beck 1999a; Beck 1999b; Kruchten 1996) for providing possibilities for striking a fine balance between flexibility and control. We found that executives valued the emphasis on up-front business planning and late-phase product launch preparation. Managers used iteration-end dates as milestones to gain a better control over schedule and scope. Developers, in turn, favored the iterative and incremental way of doing things when working towards a solution during implementation, while testers would begin their work earlier in the process, thus being able to identify defects early.

Furthermore, the findings show that the cross-functional teams are useful in integrating the stream of market information with overall development effort (Barczak 1995; Griffin 1997; Souder 1988). In both firms, the management group was interactive during the development and made decisions in real-time. In addition, at *Messaging*, the product steering group was constantly negotiating how to align internal perspectives with emerging needs and trends in the environment. This also supports the findings of the IS researchers that have promoted enabling communication among different participants in development teams (Curtis, Kellner and Over 1992; Keil and Carmel 1995; Tuunanen 2003). In the traditional IS development literature, the product requirements are commonly developed in the up-front phases, whereas in the two firms the decision-makers were involved throughout all the phases of development (Royce 1970; Sommerville 2001). The cross-functional groups clearly produced more diversified knowledge before and especially during the development, which is in line with the respective literature (Calantone, Vickery and Droge 1995; Cooper 2000).

Moreover, our findings imply that the qualities of integration, communication and flexibility can be embraced by the concept of relationship. Successful product development involves forging and nurturing relationships between the different operations involved in product development, between customers and suppliers, and between joint technology partners. For example, *Messaging* used several partnerships to enhance their responsiveness to new market opportunities. It seems that small firms can enhance the market responsiveness of the software product development by fostering a culture of communication and integration. Furthermore, this communication should not be limited to a firm but to justify the innovation process through a continuously evolving discourse of the various external parties involved (Hagedoorn 1993; Nambisan 2002).

The results show that encouraging communication during the development of software products can help to strengthen the degree of integration between different functions. In the two firms, the new information received by the teams was mainly generated and responded to at the three identified connector points. The empirical results indicate that this communication can be supported by visualization and simulation, e.g. through prototyping. This proved to help navigate through a series of decisions on the way and was, therefore, likely to improve the responsiveness to the market. Contrarily to the traditional approach where prototyping is used primarily as an engineering tool for managing technical risks and test design feasibilities (Smith 2001; Sommerville 2001), feedback was gathered from the external environment in order to adjust plans according to the gained information. In addition to managing technical risks, it appeared that the process was also built to manage business risks with regular customer feedback loops. In particular, the findings point out the importance of informal, tacit communication as a basis for these interactions.

The study also helps understand differences at the organizational level. For instance, although

the two firms had quite similar resources, they had different history of assessing and innovating software product development. Because of longer history, *Messaging* had been able to evaluate and reflect on their performance against past development efforts. This experience helped to develop systemic and coordinated communication. On the other hand, *Multimedia* had recently peaked and become more complex, and they had only loose processes in place to facilitate the integration of market knowledge with their domain. Thus, bringing together different sources of expertise was performed in an ad hoc fashion.

CONCLUSION

This study focuses on the development of mobile software products in small software firms. Based on our literature review, we present that the current IS development methods fail to incorporate market elements into the development of software products. We propose that the marketing-related NPD discussion provides the IS discipline with valuable insights into software product development and strengthens the focus on the market opportunities. The objective of NPD systems is to create new, successful product designs, while the IS methods aim at producing better and more predictable results, and implementing those improvements in the functioning of an organization. The former focuses on business risks, such as information about business objectives, customers, competitive environment and the alignment with internal functions, while the latter is strongly based on the contextual knowledge of how information systems and the latest technological developments can be used for the benefit of a customer.

In an interpretive case study of two mobile software firms, we applied both the NPD approach and the IS development methods as a lenses to identify how the participants were involved in the development of software products, and how the information was communicated between them during the phases of development. The applied framework helped us form a coherent view of the development of software products, and it showed preliminary results how to improve software product development to respond to market opportunities. As a synthesis of this study, a preliminary conceptual model is also presented describing the communication flows during the development of software product development.

While more empirical work is necessary to elaborate and verify our results, we believe that a useful starting point has been made. The purpose of our case selection was to obtain information from comparable cases, which adds confidence and robustness to the findings, but it does not ensure generalizable results. Empirical validation of the chosen approach in other settings is clearly needed. The theoretical framework was applied only to two sites, albeit in-depth. More empirical grounding will sharpen and enrich the understanding of the integration of the NPD with the IS methods and yield more complex insight to the development of software products.

In the future, we are seeking to study the recognized informal communication flows in software product development in more depth. Action research (Iversen, Mathiassen and Nielsen 2004) could provide interesting research agenda for a better understanding of these information flows. Furthermore, as organizations grow, they will most likely no longer be able to co-locate their important team members, because the products are developed across boundaries, time zones, and enterprises. This creates challenges for helping virtual product development teams to deliver successful results. Another interesting aspect that requires further investigation is concerned with the question if knowledge management capabilities can be used for distinguishing firms with a lesser success potential.

REFERENCES

Abrahamsson, P., "Extreme Programming: First Results from a Controlled Case Study," *Proceedings of the in the Proceedings of the Euromicro 2003*, Antalya, Turkey, 2003,

Abrahamsson, P., J. Warsta, M.T. Siponen and J. Ronkainen, "New Directions on Agile Methods: A Comparative Analysis," *Proceedings of the in the Proceedings of the 25th International Conference on Software Engineering*, Portland, Oregon, 2003, pp. 244-254.

Alter, S. and M. Ginzberg, "Managing uncertainty in MIS implementation," *Sloan Management Review*, 1978, 20: 1, pp. 23-31.

Barczak, G., "New Product Strategy, Structure, Process, and Performance in the Telecommunications Industry," *Journal of Product Innovation Management*, 1995, 12: 3, pp. 224.

Barki, H., S. Rivard and J. Talbot, "Toward an Assessment of Software Development Risk," *Journal of Management Information Systems*, 1993, 10: 2, pp. 203-225.

Barley, S.R., "Technology as an Occasion for Structuring: Evidence from Observations of CT Scanners and the Social Order of Radiology Departments," *Administrative Science Quarterly*, 1986, 31, pp. 78-108.

Beck, K., "Embracing Change with Extreme Programming," *IEEE Computer*, 1999a, 32: 10, pp. 70-77.

Beck, K., *Extreme Programming Explained: Embrace Change*, Addison-Wesley Longman Inc., Reading, MA., 1999b.

Beck, K., M. Beedle, A. van Bennekum, A. Cockburn, W. Cunningham, M. Fowler, J. Grenning, J. Highsmith, A. Hunt, R. Jeffries, J. Kern, B. Marick, R.C. Martin, S. Mellor, K. Schwaber, J. Sutherland and D. Thomas, "Manifesto for Agile Software Development," 2001. Available at: http://www.agilemanifesto.org/, last accessed 26th January 2006.

Boehm, B., "A Spiral model of software development and enhancement," *IEEE Computer*, 1988, 21: 5, pp. 61-72.

Boehm, B.W., B. Clark and e. al., "Cost model for future life cycle processes: COCOMO 2," *Annals of Software Engineering*, 1995, 1, pp. 57-94.

Calantone, R.J., S.K. Vickery and C. Droge, "Business Performance and Strategic New Product Development Activities: An Empirical Investigation," *Journal of Product Innovation Management*, 1995, 12: 3, pp. 214-223.

Chiesa, V., P. Coughlan and C.A. Voss, "Development of a Technical Innovation Audit," *Journal of Product Innovation Management*, 1996, 13: 2, pp. 105-136.

Clark, K.B. and S.C. Wheelwright, *Managing New Product and Process Development: Text and Cases*, The Free Press, New York, 1993.

Cockburn, A., *Agile Software Development*, Addison-Wesley, Boston, 2002.

Cooper, R., "The New Product Process: An Empirically-Based Classification Scheme," *R&D Management*, 1983, 13: 1, pp. 1-13.

Cooper, R., "Winning with New Products Doing it Right," *IVEY Business Journal*, 2000, July-August 2000, pp. 54-60.

Cooper, R.G., "Stage-Gate Systems - a New Tool for Managing New Products," *Business Horizons*, 1990, 33: 3, pp. 44-54.

Curtis, B., M.I. Kellner and J. Over, "Process modeling," *Communications of the ACM*, 1992, 35: 9, pp. 75-90.

Davis, G., "Strategies for information requirements determination," *IBM Systems Journal*, 1982, 21: 1, pp. 4-31.

De Maio, A., R. Verganti and M. Corso, "A Multi-Project Management Framework for New Product Development," *European Journal of Operational Research*, 1994, 78: 2, pp. 178-191.

Dove, R., Response Ability: The Language, Structure, and Culture of the Agile Enterprise, John Wiley & Sons, Inc., New York, 2001.

Eisenhardt, K.M., "Building Theories from Case Study Research," *Academy of Management Review*, 1989, 14: 4, pp. 532-550.

Glaser, B. and A. Strauss, *The Discovery of Grounded Theory: Strategies for Qualitative Research*, Aldine Publishing Company, Chicago, 1967.

Greiner, L.E., "Evolution and Revolution as Organizations Grow," *Harvard Business Review*, 1998,

Griffin, A., "PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices," *Journal of Product Innovation Management*, 1997, 14: 6, pp. 429-458.

Gupta, A., "The R&D-Marketing Interface in High-Technology Firms," *Journal of Product Innovation Management*, 1985, 2: 1, pp. 12.

Haeckel, S.H., "Adaptive Enterprise Design: The Sense-and-Respond Model," *Planning Review*, 1995, 23: 3, pp. 6-42.

Hagedoorn, J., "Understanding the Rationale of Strategic Technology Partnering: Interorganizational Modes of Cooperation and Sectorial Differences," *Strategic Management Journal*, 1993, 14, pp. 371-385.

Hart, S.J. and M.J. Baker, "The Multiple Convergent Processing Model of New Product Development," *International Marketing Review*, 1994, 11: 1, pp. 77-92.

Hauser, J.R., "The House of Quality," *Harvard Business Review*, 1988, 66: 3, pp. 63-73.

Heaton, L., "Talking Heads vs. Virtual Workspaces: A Comparison of Design across Cultures," *Journal of Information Technology*, 1998, 13, pp. 259-272.

Highsmith, J. and A. Cockburn, "Agile Software Development: The Business of Innovation," *Computer*, 2001, 34: 9, pp. 120-122.

Iversen, J.H., L. Mathiassen and P.A. Nielsen, "Managing Risk in Software Process Improvement: An Action Research Approach," *MIS Quarterly*, 2004, 28: 3, pp. 395-433.

Keil, M. and E. Carmel, "Customer-developer links in software development," *Communications of the ACM*, 1995, 38: 5, pp. 33-44.

Klein, H.K. and M.D. Myers, "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems," *MIS Quarterly*, 1999, 23: 1, pp. 67-93.

Kruchten, P., "A Rational Development Process," *Crosstalk*, 1996, 9: 7, pp. 11-16.

Lee, A.S., "A Scientific Methodology for MIS Case Studies," *MIS Quarterly*, 1989, 13: 1, pp. 33-52.

Mata, F.J., W.L. Fuerst and J.B. Barney, "Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis," *Mis Quarterly*, 1995, 19: 4, pp. 487-506.

Mathiassen, L., T. Saarinen, T. Tuunanen and M. Rossi, "Managing Requirements Engineering Risks: An Analysis and Synthesis of the Literature," Helsinki School of Economics, November 2004, pp. 63.

McConnell, S., "Rapid Development-Taming wild software schedules," 1986,

McFarlan, F.W., "Portfolio Approach to Information Systems," *Harvard Business Review*, 1981, 59: 5, pp. 142-150.

McGrath, M.E., Setting the PACE in Product Development: A Guide to Product and Cycle-Time Excellence, Butterworth Heinemann, 1996.

Merisalo-Rantanen, H., T. Tuunanen and M. Rossi, "Is Extreme Programming Just Old Wine in New Bottles: A Comparison of Two Cases," *Journal of Database Management*, 2005, 16: 4, pp. 41-61.

Merton, R.K., M. Fiske and P.L. Kendall, *The Focused Interview: A Manual of Problems and Procedures*, Free Press, New York, 1990.

Miles, M.B. and A.M. Huberman, *Qualitative Data Analysis: An Expanded Sourcebook*, Sage Publications, Newbury Park, CA, 1994.

Nambisan, S., "Complementary Product Integration by High-Technology Ventures: The Role of Initial Technology Strategy," *Management Science*, 2002, 48: 3, pp. 382-398.

Nandhakumar, J. and J. Avison, "The Fiction of Methodological Development: A Field Study of Information Systems Development," *Information Technology & People*, 1999, 12: 2, pp. 176-191.

Orlikowski, W.J., "CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development," *MIS Quarterly*, 1993, 17: 3, pp. 309-340.

Orlikowski, W.J. and J.J. Baroudi, "Studying Information Technology in Organizations: Research Approaches and Assumptions," *Information Systems Research*, 1991, 2: 1, pp. 1-28.

Pressman, R., Software engineering -a practitioners approach, McGraw-Hill, 2000.

Regnell, B., M. Hösta, J.N.o. Dag, P. Beremark and T. Hjelm, "An Industrial Case Study on Distributed Prioritisation in Market-Driven Requirements Engineering for Packaged Software," *Requirements Engineering Journal*, 2001: 6, pp. 51-62.

Royce, W.W., "Managing the development of large software systems: concepts and techniques," *Proc. IEEE WESTCON*, 1970, pp. (Ch. 3).

Rubin, H.J. and I.S. Rubin, *Qualitative Interviewing: The Art of Hearing Data*, Sage, Thousand Oaks, CA, 1995.

Smith, P.G., *Time-Compression Technologies*, 2001, April 2001, pp. 18-24.

Sommerville, I., *Software Engineering*, Addison-Wesley, U.S., 2001.

Souder, W.E., "Managing Relations Between R&D and Marketing in New Product Development," *Journal of Product Innovation Management*, 1988, 5, pp. 6-19.

Truex, D., R. Baskerville and J. Travis, "A Methodical Systems Development: The Deferred Meaning of Systems Development Methods," *Accounting, Management and Information Technologies*, 2000, 10: 1, pp. 53-79.

Tuunanen, T., "A New Perspective on Requirements Elicitation Methods," *JITTA: Journal of Information Technology Theory & Application*, 2003, 5: 3, pp. 45-62.

Ulrich, K.T. and S.D. Eppinger, *Product Design and Development*, The McGraw-Hill Companies, Inc., Boston, 2000.

Vainio, A.M., T. Tuunanen and P. Abrahamsson, "Developing Software Products for Mobile Markets: Need for Rethinking Development Models and Practices," *Proceedings of the Hawai'i International Conference on System Sciences HICSS-38*, Hawaii, the Big Island, 2004, pp. 10.

Walsham, G., Interpreting Information Systems in Organizations, Wiley & Sons, Chichester, 1993.

Yin, R.K., *Case Study Research: Design and Methods*, Sage Publications, Inc., Thousand Oaks, 1994.

Zahay, D., A. Griffin and E. Fredericks, "Sources, Uses, and Forms of Data in the New Product Development Process," *Industrial Marketing Management*, 2004, 33: 7, pp. 657-666.

APPENDIX 1 INTERVIEWS NOTES FOR CROSS-CASE ANALYSIS

The participants were identified in the interactions of software product development. In the table, the quotations collected for the analysis are presented

Stages	Multimedia	Messaging
Scoping / Requirement Elicitation	The CEO: "The management group focuses on what will be built and tries to collect information through our industry network at customers, partners and technology forums to make a prelim market assessment." The CEO: "We have formed few partnerships with telecom operators just to be more alert in the market. They aren't the most profitable customers, but they will inform us of the future development." The CEO: "We don't have any link to the end users. It would be too expensive us to collect systematically data from the market." The CEO: "We know a lot of people in this industry and we talk a lot with them. Of course, our salesmen are able to collect a lot of feedback."	The head of business development: "Account managers collect feedback from customers and save it in a database." Competitors are tracked systematically with the help of supply requests and market follow-up. Just yesterday I finished a slide show about competitors. Network partners! The CEO: "We collect customer feedback through a digital channel and stored it in a database. The responses are given priorities according to three levels and the results are reviewed in the management group and the product steering group." The head of business development: "Last year we conducted a market study for the main customers. We wanted to study the current market situation, the future trends, and the timing of those trends. On the basis of the results, we adjusted our plans. We [marketing department] will repeat the research yearly." The CTO: "The quality survey is conducted for current customers at regular intervals."
Building Business Case / Requirement Analysis	The CEO: "However, because of limited resources, we have to trust on the common touch. Last time the management group held a meeting in a cottage in Lapland. We didn't come back until we had finalized the plans." The CEO: "All [developers and account managers] talk a lot around the coffee table to analyze the plans." The head of technology: "After defining an initial value proposition, the salesmen of the firm start to collect the final proofs by questioning few customers: Would you like this kind of feature..?"	The CEO: "All functions perform analysis in traditional ways. For example, financial calculations are very important." The head of business development: "The decisions are reviewed by the product steering group that gathers all functions together. We meet once in three months and discuss the main guidelines for the new product development." The CTO: "Software engineers contribute their part by testing the concept of an idea. Then we simply tell the idea to our customers and let them play with demos. If they would be willing to pay for the idea, then we let thighs slide." The CEO: "The product steering group decides when to start the development and the management group approves the definitions and plans."

The participants were identified in the interactions of software product development. In the table, the quotations collected for the analysis are presented (Cont'd)

Implementation / Component Factory	The head of technology: "The product features are developed according the plans. The development team is responsible for the technological feasibility of the product concept. "	The CTO: "Based on the plans, software engineers and technology architects start development. It is better that there are different people to figure out what is the easiest way to develop features which is not the point on previous stages. Their role is sort of to optimize the plans."
Testing & Validation / Product Integration	The CEO: "A prototype is always developed, but it actually serves more the sales department than development. It is not productive to present a piece of code to anyone; we have to conceptualize the product to collect the final customer feedback. Otherwise, it is difficult to transmit an image of the product concept. At this point, the sales and business development manager start to contact potential customers." The head of technology: "First, the functionality of the product is verified internally [by software engineers]. Then, external testing of the product feature is performed by delivered demo versions to customers in order to get feedback. However, this requires the same amount of work than normal product implementation why we don't perform this in every case.	The CTO: "Software engineers test the product functionality and then perform customer field trials. I and some account managers discuss with customers to get the in-depth feedback. The customers explore the product from the business perspective." The CEO: "The head of business development with marketing contacts potential sales partners. They strengthen our position because then we can offer a comprehensive solution."
Launch	The CEO: "Market launch and roll-out is often performed in the most important fairs, such as Cannes and GSM World. I go there with sales and marketing. The purpose is to present the product to customers." The head of technology: "Based on the first feedback, we might still fix some technological problems."	The CEO: "Market introduction is performed at the main industry fairs, such as GSM World or Cannes. All main functions are present, but, of course, sales and marketing are doing the main job meeting customers." The CEO: "The product is also introduced to our partners and to members of technology forums." The CEO: "Results are monitored in the management group. And then there are that after sales quality survey.."

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Exchange and Combination of Knowledge-Based Resources in Network Relationships: A Study of the Effects on Organizational Effectiveness of New Software Firms

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Exchange and combination of knowledge-based resources in network relationships

A study of software firms in Finland

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Abstract

Purpose – To gain a better understanding of various network relationships in the software industry by classifying relationships by type and identifying distinctions with respect to the business potential of those relationships.

Design/methodology/approach – On the basis of literature, the study presents a framework for the tasks of combining and exchanging knowledge-based resources in network relationships. In the empirical research setting, the relationships of nine Finnish software firms are first classified and placed in the framework, and then the organisational effectiveness of the relationships is measured.

Findings – The findings reveal three relationship types, each leading to different effectiveness profiles.

Research limitations/implications – It is recognised that this exploratory multiple-case study raises the concern of generalisability and, thus, a statistical research using more accurate quantitative methods could be useful in checking the validity of the findings. Further, the selected cases exclude non-networking companies, which is why future researchers may wish to consider whether the conclusions are valid across all firms and not just for those already in relationships.

Practical implications – A very useful information for new software firms having and planning partnerships in the software industry. For a new venture with limited resources, in particular, the partnerships may offer valuable resources. The study advances the identification of those benefits.

Originality/value – This study extends the understanding of management in strategic networks, particularly in the software industry, by classifying network relationships by type, describing the potential of these relationships, and indicating the capabilities needed for managing specific types of relationships.

Keywords Knowledge management, Finland

Paper type Research paper

Introduction

Partnering activities are important for the success of software products for the reason that they create interdependencies and synergies enabling, augmenting and extending the effectiveness of the partners. According to the resource-based view (Penrose, 1959; Barney, 1991), partnerships with other organisations constitute valuable capital by providing access to complementary resources and capabilities that may otherwise be unavailable. The underlying logic for this argument lies in the view that firms are heterogeneous entities differing in capabilities and resources (Wernerelt, 1984). By accessing complementary resources through cooperating with other organisations, a firm is able to improve its competitive advantage (e.g. Gulati, 1998; Hagedoorn, 1993; Hoch *et al.*, 1999).

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Håkanson (1989) and Van de Ven and Ferry (1980) describe a network as a total pattern of relationships within a group of organisations; firms recognise that the best way to achieve common goals is to co-ordinate the business system in an adaptive fashion. Campbell and Wilson (1996) suggest that superior resources can also emerge from a synergy resulting from coordination of independent firms in a series of value-adding partnerships. For example, out of partnerships formed through industry forums such as Symbian (www.symbian.com), a software firm can deliver innovative solutions together with its network partners. This kind of cooperation aims to recognise the potential for synergy in developing capabilities that reinforce rather than minimise their dependence on partner firms. Campbell and Wilson (1996) have proposed a value-creating network describing purposeful cooperation between independent firms along a value-added chain for creating strategic advantage for the entire group. This definition focuses on the overall relationship between business organisations and includes both the exchange and social relationships. As social aspects are important for network formation (Beije and Groenewegen, 1992, e.g. Granovetter, 1985), the definition is also suitable for this study.

In view of these arguments, this paper attempts to gain a better understanding of the various network relationships prevailing in the software industry by studying the current literature with the aim of classifying relationships by type and finding distinctions with respect to the business potential of those relationships. After a literature survey, a framework is presented, consisting of two dimensions for the tasks of combining and exchanging knowledge-based resources in network relationships. The empirical research setting is twofold. First, the relationships of nine Finnish software firms are studied and placed in the framework. Second, the organisational effectiveness of those relationships are measured against Quinn and Rohrbaugh's (1983) framework. The findings revealed three existing relationship types leading to different effectiveness profiles. This study extends the understanding of management in strategic networks, particularly in the software industry, by classifying network relationships by type, describing the potential of these relationships, and indicating the capabilities needed for managing specific types of relationships.

The paper is structured as follows. First, the importance of network relationships in the software industry is analysed on the basis of the literature survey. Second, the framework is created by studying the exchange and combination of knowledge-based resources in business networks. After introducing the methodology of a multiple-case study comprising nine young Finnish companies, a classification of a total of 36 relationship types and an evaluation of the organisational effectiveness of such relationships are presented. Finally, the findings are discussed and the major conclusions are highlighted.

Network relationships in the software industry

Especially in the software industry, both the number of partnerships and the average value per partnership have been increasing steadily (Hoch *et al.*, 1999; Hietala *et al.*, 2002). Although it has been established that the size of the firm has a positive effect on alliance participation (Berg *et al.*, 1982), small software ventures are attractive partners because of both their innovativeness and flexible nature, which accounts for factors associated for positive learning outcomes for both parties in a partnership (Hamel, 1991). From a new software firm's perspective, these interconnected relationships can

offer unique and valuable assets and capabilities. Given that the resource limitations of start-ups make them prone to the liabilities of newness and adolescence (Amburgey *et al.*, 1993), this perspective also helps to explain how and why some new software firms are able to grow and survive despite the lack of significant firm-specific resources.

According to Hagedoorn (1993), the motives most often mentioned behind technology partnerships are technology complementarities, innovation time-span reduction, market access, and market structure influence. Other aims behind alliance formation in volatile, high-tech industries are to accelerate time to market, to increase market penetration, to divide the immense costs of developing the technology, to manage the uncertainty involved in emerging technologies, to further the convergence of several industry segments, and to combat the "follow the herd" mentality (Parise and Henderson, 2001; Gulati, 1998; Sengupta, 1998). By integrating their primary software product with other well-known and established software products, new ventures can gain enhanced market visibility, product repute, and customer trust (Sengupta, 1998). Nevertheless, technological standards or common interest in technology development may also be motives for joining partner webs, which may consist of even hundreds of informal, yet highly performance-driven partnerships (Hoch *et al.*, 1999). To conclude, this study is based on the view that one salient reason for collaboration in high technology sectors is the possibility of bringing together complementary assets to marshal a full array of capabilities.

Few high-technology products function in isolation. The partnerships typically take the form of research and development (R&D) agreements, in which a product is developed that will help sell the focal firm's product, or joint marketing alliances, in which the focal firm will "bundle" the complementor's product with its own (Parise and Henderson, 2001; Sengupta, 1998). However, as the different forms of these relationships overlap, the partnerships may include both R&D cooperation and joint marketing arrangements.

Co-operation can be formed either vertically or horizontally. Vertical alliances are cooperative relationships between channel participants aiming at a solution for marketing problems, improved production efficiency, or the exploitation of market opportunities. These networks efficiently promote, modify and move goods to markets. Networks can also consist of horizontal partnerships among companies wishing to solve a common marketing problem, to improve production efficiency, or to exploit a market opportunity through resource mobilisation and sharing.

Exchange and combination of knowledge-based resources

In order to gain a better understanding of the various relationships and networks, a model was developed to classify the relationships by type according to network characteristics. Similarly to Schumpeter (1934), Moran and Ghoshal (1996) have argued that all new resources, including knowledge, are created through two generic key processes: combination and exchange. The framework was based on this argument, while setting the following dimensions for the model:

- the value system describing the nature of the combination of knowledge resources; and
- social capital describing how the exchange of knowledge is facilitated by social interaction, network ties and trust embedded in network relationships.

The framework of the two dimensions creating four combinations is presented in Figure 1.

These combinations reflect the process viewed by Schumpeter as the foundation for economic development – "to produce means to combine materials and forces within out reach (1934)". This is in line with Håkanson and Snehota (1995), who have suggested that value creation in relationships is based on value activities and actors, and how they combine resources through activity links. Researchers have identified two types of value creation as regards combining knowledge-based resources (e.g. Håkanson and Snehota, 1995; Möller and Svahn, 2003). First, value can be created through stable, incremental change and development of existing knowledge. Second, the authors also discuss a more radical change involving innovation and emerging value activities. Both types of value creation involve creating new combinations – incrementally or radically – either by combining elements previously unconnected or by developing novel ways of combining resources previously associated. This type of combining of knowledge-based resources can be illustrated by a simplified dimension of value system ranging from clearly specified and stable systems to emerging value systems (adapted from Möller and Svahn, 2003).

The exchange of knowledge-based resources is embedded in ongoing networks of personal relationships and accompanied by non-economic goals such as sociability, approval, status and power (Granovetter, 1985). The social embeddedness of economic exchange has also been referred to by a number of other researchers (e.g. Kogut and Zander, 1992; Cohen and Levinthal, 1990; Beije and Groenewegen, 1992). Through close social interaction, firms are able to enhance the depth, breadth, and efficiency of mutual knowledge exchange in relationships (Dyer and Singh, 1998; Lane and Lubatkin, 1998). Based on these arguments, a dimension of social capital is inserted into the model. Social capital is defined as the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by a new software firm (Nahapiet and Ghoshal, 1998). Social capital thus comprises both the network and the assets that may be mobilised through that network (Burt, 1992). However, the focus of the analysis is on social knowledge alone due to the fact that it

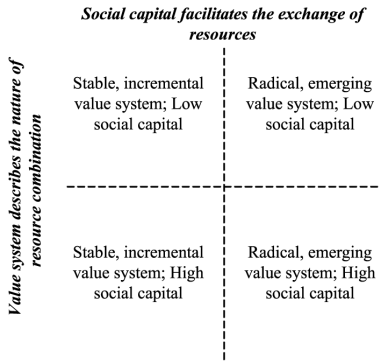

Figure 1.
Framework of value creation in network relationships

has been argued that collective knowledge is the most secure and strategically significant kind of organisational knowledge (Spender, 1996).

Using Nahapiet and Ghoshal's (1998) framework, the paper conceptualises social capital with the help of three different dimensions, which nevertheless overlap to a considerable extent. The structural dimension of social capital refers to the overall pattern of connections between actors – that is, who you reach and how you reach them (Burt, 1992). Among the most important facets of this dimension is the presence or absence of network ties between actors (Scott, 1991). The relational dimension of social capital focuses on the particular relationships that people have, such as respect and friendship, which influence their behaviour. The key facets of this dimension are trust and trustworthiness (Putnam, 1995; Fukuyama, 1995), norms (Putnam, 1995), obligations and expectations (Burt, 1992; Granovetter, 1985), and identity and identification (Håkanson and Snehota, 1995). Finally, the cognitive dimension of social capital involves such resources as shared languages and codes that are needed for providing shared interpretations and systems of meaning among the parties (Nahapiet and Ghoshal, 1998).

The two dimensions, value system and social capital, form four combinations illustrating different types of relationships. In summary, the framework suggests that although all the types provide value, it is for different purposes. The combination of either stable or radical resources is regulated by the amount of social capital embedded in such relationships. By building relation-specific assets and relational governance mechanisms into relationships, firms are able to tap into the knowledge resources of their exchange partner.

Research methodology

In order to explore the various types of network relationships of new software firms and to analyse whether and in what ways these relationships affect the organisational effectiveness of a firm, a multiple-case study including nine young Finnish companies was carried out. The companies were selected due to their growth intentions, small size and the variation of their products. Since versatility is the major strength of a case study (Eisenhardt, 1989; Yin, 1994), various sources of evidence and data collection methods were used to provide greater validity for the findings.

All of the companies chosen had been carrying on business for less than five financial years or the size varied from 10 to 65 employees. Additionally, all the firms acknowledged a strong growth initiative. The cases can also be described as a convenience sample because the researcher had previously been cooperating with the companies. However, it can be stated that the selected companies constitute a good representation of the type of software product ventures defined as the focus of our study. The details of the companies are illustrated in the appendix.

The methods used in this study for data collection were theme interviews, structured interviews, and acquisitions of written documents and information from the companies chosen. Brochures, annual reports, internal documents and trade journal articles were also collected and used for the analyses. The purpose was to collect information for a classification of relationships and for measuring the organisational effectiveness of such relationships. The data collection succeeded well in each of the nine cases, and the relationships of the different organisations were specified, classified

by type and finally measured with Quinn and Rohrbaugh's (1983) effectiveness approach.

Classification of relationships

The nine companies studied showed a total of 36 different types of relationship. The study took into account only the relationships that complemented the software product of a company. Accordingly, relationships with bookkeepers, investors, and non-strategic suppliers such as those for office materials were left out. Although these relationships may offer valuable contacts, information and references, they do not add value to the software product beyond its basic functionality. The relationships were arranged in a model through conducting a two-hour theme interview in each company. The main informant of the interview was the CEO, a partner manager or a sales director. Furthermore, it was checked that other company-specific material such as internal documents, news statements, and brochures supported the findings of the interviews.

The relationships were placed on a two-dimensional graph of social capital and value systems as follows:

Social capital. The amount of social capital was categorised as high or low by means of the 12 themes in the interview. All relationships were mapped on the continuum of the model without problems. The social capital variables are described in more detail in the appendix.

Value system. The nature of the value system was codified as either stable and incremental or radical and emerging according to the 8 themes used in the interview. There were no problems in mapping the relationships on the continuum. The value system variables are described in more detail in the appendix.

Finally, all of the relationships were arranged into the four combinations. However, there were no relationships representing the category "radical and emerging value system with low social capital". For this reason, it was not possible to measure the organisational effectiveness of such relationships, but only to draw some conclusions of this non-appearance.

Effect on the organisational effectiveness of a firm

After grouping the relationships in the four combinations of the model, the average effectiveness of the existing three relationship types was measured. A structured interview was designed to measure the organisational advantage gained from a relationship. Structured interviews are a good method for testing formal hypotheses and presenting the collected data in a quantitative form (Robson, 1995). The CEOs of the companies were the objects of these interviews. The aim was to identify how a relationship defined in terms of the value system and the amount of social capital can lead to different profiles of effectiveness occurrences.

The organisational effectiveness of each of the relationships (36) was measured as follows:

Effectiveness. Quinn and Rohrbaugh's (1983) framework of organisational effectiveness was used to measure the value appropriation in new software firms. This widely used framework was chosen due to the fact that the model comprises an overall framework for analysing multidimensional behaviour taking place in organisations. The framework conceptualises the criteria for organisational

effectiveness according to the three axes of value dimensions. The first value dimension is related to organisational focus – internal or external. The second value dimension is related to organisational structure, ranging from an emphasis on stability to an emphasis on flexibility. The third value dimension is related to organisational means and ends, from an emphasis on important processes to an emphasis on final outcomes. The three dimensional criteria of effectiveness also make possible the identification of four basic models: human relations, open system, internal process, and rational goal model. According to Quinn and Rohrbaugh, an effective organisation may need to perform well in all four models of the framework.

On the basis of an extensive literature survey and the considerations of effectiveness measurement (Lewin and Minton, 1986), organisational effectiveness was defined with 32 effectiveness items. The coverage of these items was checked by comparing them with the Quinn and Rohrbaugh framework. Finally, the items were refined to be suitable and relevant for the software product industry. The effectiveness variables are described in more detail in the appendix.

A structured interview was designed using the variables described. The questionnaire was filled out by the CEO for every relationship of the company. The respondent assigned a value to each effectiveness item, the scale ranging from zero to two (0 denoting no effect, 1 a minor positive effect, and 2 a major positive effect). As a result, questionnaires were gathered for all of the 36 relationships. Finally, the averages of 32 effectiveness items were calculated for each of the three combinations of relationships.

Results

The results of the classification of network relationships for the companies included in this research are illustrated in Figure 2.

As mentioned before, there were no instances representing the combination of emerging value system with low social capital to be found among the relationships studied. To describe the nature of cooperation, the relationships were named on the basis of announcement types: OEM agreement, sales partnership, technology supplier, R&D cooperation, R&D with a customer, delivery channel, and industry forum. The details of the relationships are illustrated in the appendix.

The averages of the organisational effectiveness items are presented in Table I.

Discussion

Stable, incremental value system; high social capital

Among the 18 relationships representing this combination, there were five highly coordinated and strong OEM agreements and eight long-term sales partnerships. In addition to these marketing-oriented relationships, there were also two R&D cooperation agreements with large global companies and three technology suppliers. In the R&D alliances, the exchange of technology was clearly specified in the agreements that might eventually turn into licensing or OEM contracts along with the maturing of co-developed product features. The technology suppliers, or preferably consulting companies, were delivering special technological skills and project resources as needed, while invoicing was time-based. Thus the cooperation was more like resource providing. Aside from these small suppliers, all partners were of the same

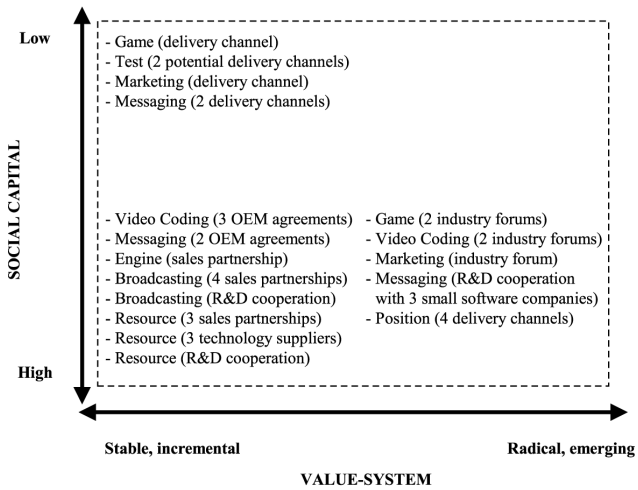

Figure 2.
Network relationships of the selected companies (total amount of relationships, 36)

size or clearly larger. The respondents pointed out that large companies provided a solid base for cooperation as they often had better resources and larger capacity.

The average of effectiveness items for the human resource model was 1.41 on a scale from zero to two, which indicated that the cooperation was contributing to the cohesion and morale of the organisation with emphasis on human resources and learning. Motivation and employee satisfaction, ability to cooperate and technological distinctiveness were found to gain the greatest benefit (1.63). To conclude, it appears that a consistent and gradual combination of resources and high social capital between partners supports the construction of a common social system consisting of cooperating members. In addition to the enhancement of the social system, there was improvement to be seen in resource-training items such as learning, innovating and crisis management. In addition to the effects on human resources, this type of relationships also appeared to substantially affect the other models (1.13-1.88). This suggests that the learning outcomes had already turned into benefits for issues related to the open system model, the internal process model, and the rational goal model.

The relationships had the strongest effect on the open system model (average 1.75). The respondents described how these long-term relationships were maintaining the organic system with emphasis on adaptability, growth and resource acquisition through advanced risk management and timely implementation of change. In spite of the stability and discipline of the cooperation, these relationships brought innovation and creativity, which indicates that familiar context and incremental approach are suitable for increasing flexibility in risk-averse high technology sectors.

Because of the regular audits performed by the partners, the companies invested a great deal in improving internal operations, such as quality control and information management. This explains why the relationships had a relatively strong effect on internal process related issues with an average of 1.52, as the companies were elaborating their measurement, documentation and information management

	Effectiveness criteria		
	Stable, incremental value system High social capital (18)	Radical, emerging value system High social capital (12)	Stable, incremental value system Low social capital (6)
Human resource model			
Initiative	1.13	1.60	0.00
Motivation, *esprit de corps*	1.63	2.00	0.25
Employee satisfaction	1.38	1.80	0.00
Organisational learning	1.25	1.80	0.25
Capability of co-operating	1.63	1.60	0.50
Capability og managing crisis	1.25	1.20	0.25
New product innovations	1.38	1.80	0.50
Technological distinctiveness	1.63	1.80	0.00
Total average	1.41	1.70	0.22
Open system model			
Controlled growth of operations	1.63	1.00	0.75
Control of market uncertainty (risk management)	1.75	1.20	0.50
Structure/strategy congruence	1.63	0.80	0.75
Organisation/environment fit	1.63	1.40	0.75
Customer-oriented focus	1.88	1.80	0.75
Knowledge and resource acquisition	1.88	2.00	1.25
Reputation, trust, market visibility	1.75	1.40	1.75
Competitive position	1.88	1.00	1.25
Total average	1.75	1.33	0.97
Internal process model			
Change management	1.38	0.00	0.00
Authority, discipline	1.63	0.20	0.00
Quality control	1.50	0.20	0.00
Efficient information processing	1.63	0.40	0.00
Documentation of processes	1.50	0.00	0.00
Congruence of processes	1.63	0.20	0.00
Protecting core assets	1.13	0.00	0.00
Efficiency through economies of scale	1.75	0.00	0.25
Total average	1.52	0.13	0.03
Rational goal model			
Product maximisation	1.63	0.20	1.00
Optimal use of resources	1.63	0.40	0.50
Minimising costs	1.25	0.20	0.50
Productivity	1.38	0.40	0.75
Return on investment	1.20	0.00	0.00
Profitability	1.50	0.40	0.50
More focused business objects	1.88	0.80	0.50
Sales growth	1.63	0.80	1.25
Total average	1.51	0.40	0.63

Table I.
Averages of effectiveness items (total number of relationships 36)

processes. This type of relationships appeared to contribute to the stability and control of internal actions due to the fact that tasks were well understood. The average of the rational goal related effects on was 1.51, which indicates a financial profitability of the relationships and a positive influence on rational action. For example, the respondents reported business objects having become more focused (1.88), which had led to clarified tasks and, accordingly, to more resolute actions.

The purpose of these relationships was to interlink the partners for better integration and to rationalise the value chain of the focal product (e.g. firms align with their suppliers to achieve better quality deliveries, to improve the market penetration, and to reduce cost). Relationships turned out to be perceived as successful for the reason that they were likely to increase the outcome of combined activities and to rationalise the cost of performing these activities. The study also suggest that high social capital is a precondition for mutual learning and development work; development teams appeared to perform better in an informal and social environment. As a result, the value created often resulted in strategic or highly differentiated capabilities in relationships, which were seen as institutionalised activities and strong social relations between the actors. Furthermore, the findings suggest that a sufficient size of the partner is a precondition for a small company to achieve the benefits described above.

Radical, emerging value system; high social capital

The 12 relationships representing this group consisted of five industry forums, three R&D cooperation agreements with other small companies, and four delivery channels. The relationships of this combination were aiming to produce new innovations, market information and radical technology developments through resource mobilisation and sharing. The relationships with industry forums formed a dyad of a partner web combining resources in order to develop an emerging product market. The purpose of the R&D cooperation was to produce new product combinations. All four delivery channels of company position were still in engagement stage without clear agreements, which was why the configuration was still highly changeable and thus classified as emerging.

The relationships had the most obvious effect on human resources issues, as the average was 1.70. The respondents pointed out significant improvements in motivation (2.00), employee satisfaction (1.80), and organisational learning (1.80). Furthermore, this type of relationships accounted for positive outcomes in terms of new product innovations (1.80) and technological distinctiveness (1.80). Although these improvements are reported to be higher for relationships having to do with emerging value systems than those of a stable, incremental one, the relationships of this combination had only a negligible effect on the internal process model (average 0.13) and rational goal issues (average 0.40). This indicates that in radical and emerging value systems the partners continuously develop their knowledge but also that the learning is not fully accomplished.

Due to the fact that the relationships discussed above appear to have failed to contribute to the control and stability of the organisations, it seems that this type of relationship does not provide the skills or resources needed for exploiting the cost advantage either. On the other hand, the relationships provide the respective organisations with an excellent "antenna" for fathoming the external environment.

This creative flair, proven by the high averages for both open system and human resources models, helps to build up a unique combination of skills drawn from other businesses. In addition, the respondents reported improvement regarding the reputation for quality and technological leadership needed for differentiation of products. This shows that the context of emerging and radical changes is beneficial for improving organisational flexibility and adaptive function.

Excluding four vague delivery channels, all of the relationships involved partners integrating their tacit knowledge to jointly develop innovations in the form of new products or technologies. Partner learning was a major objective of each partner. However, through these network relationships learning was rarely fully accomplished or ideas implemented, which is confirmed by the low scores for the control functions of integration and goal-attainment. The actor bonds of the relationships were emerging dynamically; some were declining and others being formed when new organisations joined the forum. The social capital between the members was high; otherwise, the bonds between actors would seem to weaken. There were no formal agreements or explicit rules for operating in the network. This sort of dynamics in relationships seems to contribute to high flexibility, while also presenting itself as an obstacle to moving towards a more centralised structure.

Stable, incremental value system: low social capital

All the six relationships representing this combination were marketing channel agreements, in which one partner provides market access or a brand name, while the other provides the product to market. The shape of the cooperation agreements varied, the strongest occurrences being technology licensing agreements with one partner paying royalties to gain access to the other partner's technology, and the weakest were merely letters of intent. All six partners were large foreign corporations and there were no social relationships involved in the liaisons.

The respondents described that no new products or technologies were developed between the partners, and that there was very little joint effort or integration apart from written contracts. The incentives of the agreements were based on quantitative targets such as the amount of sales. The technological resources exchanged were usually in codified form. As tacit knowledge was not provided, very little learning took place between the partners. Overall, this weak social commitment between actors easily led to loose connections and inefficiencies.

Compared with the strong effect of relationships on the human resources model in both stable and emerging value systems, the impact was small, with an average of 0.22, for the combination of stable, incremental value system and low social capital. Therefore, in line with this finding, the study confirms that high social capital in network relationships facilitates organisational learning from the perspective of a new software firm. Furthermore, the effect on the internal process model, showing an average of 0.03, was weak. Thus, the study concludes that this type of relationships does not have any significant effect on the internal focus of an organisation. The relationships clearly contributed the most to the external focus of the company as improvements were reduced to the goal-attainment and adaptive functions. Although the effect for this combination was rather minor, with an average of 0.63 for the rational goal and 0.88 for the open system model, the relationships did produce some financial outcomes and provided companies with useful market information.

The relationships of the case companies proved to offer them opportunities to form vertical distribution systems and helped them structure their organisational responsibilities and activities. While the value gained from this type of relationships may not be sufficient to make the business take off, they still enable some benefit to be gained in terms of increased sales to new customers. Additionally, any preliminary work done on these relationships appears to provide potential for more powerful cooperation.

Summary and conclusion

The study aims at understanding how network relationships can be used to access the complementary resources needed for managing software product business. Hence, the need for a more specific conceptualisation of the network relationships was suggested. This study proposes a framework classifying the different relationships according to network characteristics. The two dimensions of the framework comprise a "value system", describing the nature of resource combination, and "social capital", illustrating how the exchange of knowledge-based resources is facilitated by social interaction, network ties, and trust embedded in network relationships. Finally, in the empirical research setting, Quinn and Rohrbaugh's (1983) effectiveness approach was employed to identify the potential offered by the classified relationships.

Building on a multiple-case study approach, the study bases its analysis on various sources of data, such as theme interviews, structured interviews and the acquisition of written documents and information from the subject companies. In the empirical setting, 36 relationships were named in the nine companies involved, and placed in the framework. On the basis of this classification, three types of relationships leading to different effectiveness profiles were identified. Firstly, the relationships of a stable, incremental value system bundled with high social capital was found to contribute equally to all major organisational functions, including human resources, adaptation, goal-attainment and integration. The findings suggest that this type of familiar and stable context involving an incremental development approach is suitable for increasing flexibility and competitiveness in risk-averse high technology sectors. Secondly, the effect of relationships for the combination of emerging value system and high social capital proved likely to emphasise the flexibility and decentralised structure of an organisation. However, the results also indicated that learning and readiness could not be fully exploited by the respective organisations for the reason that the effect of relationships on centralisation-integration related values was insignificant. Because of the emerging context, there was no consistency in implementing improvements in the internal structure. Thirdly, the relationships of a stable, incremental value system coupled with low social capital appeared to contribute to the adaptation and goal-attainment capabilities of an organisation. In all, the impact of relationships was primarily focused on external issues. Although there was hardly any effect on internal equilibrium and human resources, the relationships contributed to some extent to productivity, efficiency, growth, and resource acquisition. Lastly, the as no relationships could be found for the combination of emerging value system and low social capital, it can be concluded that such an inconstant context of loose bonds is not likely to be beneficial for improving the effectiveness of businesses.

Limitations and issues for further research

More research on partnering among new software firms is clearly needed. It is also recognised that this exploratory multiple-case study raises the concern of generalisability and, thus, a statistical research using more accurate quantitative methods could be useful in checking the validity of the findings. However, this study involving nine companies yields some promising results. Further, the selected cases exclude non-networking companies, which is why future researchers may wish to consider whether the conclusions are valid across all firms and not just for those already in relationships. Another interesting direction for continuing the research could be an analysis of companies exploiting these network relationships during organisational development as regards product development. Additionally, a systematic longitudinal study would reveal how the benefits gained from co-operation evolve during the development of relationships.

References

Alvarez, S.A. and Meyer, G.D. (1999), "Technology-based strategic alliances: are they good for entrepreneurial firms?", *Frontiers of Entrepreneurship Research*, Babson College, Babson Park, MA.

Amburgey, T.L., Kelly, D. and Barnett, W.P. (1993), "Resetting the clock: the dynamics of organizational change and failure", *Administrative Science Quarterly*, Vol. 38, pp. 51-73.

Barney, J. (1991), "Firm resources and sustained competitive advantage", *Journal of Management*, Vol. 17 No. 1, pp. 99-120.

Beije, P.R. and Groenewegen, J. (1992), "A network analysis of markets", *Journal of Economic Issues*, Vol. 26 No. 1, pp. 87-104.

Berg, S.V., Duncan, J. and Friedman, P. (1982), *Joint Venture Strategies and Corporate Innovation*, Oelgeschlager, Gunn & Hain, Cambridge, MA.

Brown, S.L. and Eisenhardt, K.M. (1995), "Product development: past research, present findings and future directions", *Academy of Management Review*, Vol. 20 No. 2, pp. 343-78.

Burt, R.S. (1992), *The Structural Holes: The Social Structure of Competition*, Harvard University Press, Cambridge, MA.

Calantone, R.J., Cavusgil, S.T. and Zhao, Y. (2002), "Learning orientation, firm innovation capability, and firm performance", *Industrial Marketing Management*, Vol. 31 No. 6, pp. 515-24.

Campbell, A.J. and Wilson, D.T. (1996), "Managed networks: creating strategic advantage", in Iacobucci, D. (Ed.), *Networks in Marketing*, Sage Publications, London, pp. 125-43.

Chandler, A.D. (1962), *Strategy and Structure*, MIT Press, Cambridge, MA.

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive capacity: a new perspective on learning and innovation", *Administrative Science Quarterly*, Vol. 35 No. 1, pp. 128-52.

Cooper, R. (1983), "The new product process: an empirically-based classification scheme", *R&D Management*, Vol. 13 No. 1, pp. 1-13.

Dyer, J.H. and Singh, R. (1998), "The relational view: cooperative strategy and sources of interorganizational competitive advantage", *Academy of Management Review*, Vol. 23 No. 4, pp. 660-79.

Eisenhardt, K. (1989), "Building theory from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-50.

Fayol, H. (1949), *Administration Industrielle et Générale*, Sir Isaac Pitman & Sons, London.

Fukuyama, F. (1995), *Trust: Social Virtues and the Creation of Prosperity*, Hamish Hamilton, London.

Granovetter, M. (1985), "Economic action and social structure: the problem of embeddedness", *American Journal of Sociology*, Vol. 91, pp. 481-510.

Gulati, R. (1998), "Alliances and networks", *Strategic Management Journal*, Vol. 19, pp. 293-317.

Hagedoorn, J. (1993), "Understanding the rationale of strategic technology partnering: interorganizational modes of cooperation and sectorial differences", *Strategic Management Journal*, Vol. 14, pp. 371-85.

Håkanson, H. (1989), *Corporate Technological Behaviour: Cooperation and Networks*, Routledge, London.

Håkanson, H. and Snehota, I. (1995), *Developing Relationships in Business Networks*, Routledge, London.

Hamel, G. (1991), "Competition for competence and interpartner learning within international strategic alliances", *Strategic Management Journal*, Vol. 12, pp. 83-103.

Hietala, J., Maula, M.V.J., Autere, J., Lassenius, C. and Autio, E. (2002), *Finnish Software Product Business: Results from the National Software Industry Survey*, Helsinki University of Technology, Espoo.

Hoch, D., Roeding, C., Purkert, G. and Lindner, S. (1999), *Secrets of Software Success*, Harvard Business School Press, Boston, MA.

Kale, P., Singh, H. and Perlmutter, H. (2000), "Learning and protection of proprietary assets in strategic alliances: building relational capital", *Strategic Management Journal*, Vol. 21, pp. 217-37.

Kazanjian, R.K. and Drazin, R. (1990), "A stage-contingent model of design and growth for technology-based new ventures", *Journal of Business Venturing*, Vol. 5, pp. 137-50.

Kogut, B. and Zander, U. (1992), "Knowledge of the firm, combinative capabilities and the replication of technology", *Organization Science*, Vol. 3 No. 3, pp. 383-97.

Koka, B.R. and Prescott, J.E. (2000), "Strategic dimension as social capital: a multidimensional view", *Strategic Management Journal*, Vol. 23, pp. 795-816.

Krishnan, V. and Bhattachraya, S. (2002), "Technology selection and commitment in new product development: the role of uncertainty and design flexibility", *Management Science*, Vol. 48 No. 3, pp. 313-27.

Lane, P.J. and Lubatkin, M. (1998), "Relative absorptive capacity and interorganizational learning", *Strategic Management Journal*, Vol. 19 No. 5, pp. 461-78.

Larson, A. (1992), "Network dyads in entrepreneurial settings: a study of the governance of exchange relationships", *Administrative Science Quarterly*, Vol. 37, March, pp. 76-104.

Lawrence, P.R. and Lorsch, J.W. (1967), *Organization and Environment*, Division of Research, Harvard Business School, Boston, MA.

Lewin, A.Y. and Minton, J.W. (1986), "Determining organizational effectiveness: another look, and an agenda for research", *Management Science*, Vol. 32 No. 5, pp. 514-38.

Likert, R.L. (1967), *The Human Organisation*, McGraw-Hill, New York, NY.

Lorsch, J.W. and Morse, J.J. (1974), *Organizations and Their Members: A Contingency Approach*, Harper & Row, New York, NY.

McGregor, D. (1960), *The Human Side of Enterprise*, McGraw-Hill, New York, NY.

Möller, K. and Svahn, S. (2003), "Managing strategic nets: a capability perspective", *Marketing Theory*, Vol. 3 No. 2, pp. 209-34.

Moran, P. and Ghoshal, S. (1996), "Value creation by firms", in Keys, J.B. and Dosier, L.N. (Eds), *Academy of Management Best Paper Proceedings*, Statesboro, SC, pp. 41-5.

Nahapiet, J. and Ghoshal, S. (1998), "Social capital, intellectual capital, and the organizational advantage", *Academy of Management Review*, Vol. 23 No. 2, pp. 242-66.

Nohria, N. and Garcia-Pont, C. (1991), "Global strategic linkages and industry structure", *Strategic Management Journal*, Vol. 12, pp. 105-24.

Parise, S. and Henderson, J.C. (2001), "Knowledge resource exchange in strategic alliances", *IBM Systems Journal*, Vol. 40 No. 4, pp. 908-24.

Penrose, E. (1959), *The Theory of the Growth of the Firm*, Blackwell, Oxford.

Peters, T.J. and Waterman, R.H. Jr (1982), *In Search of Excellence*, Harper & Row, New York, NY.

Pfeffer, J. and Salancik, G.R. (1978), *The External Control of Organizations: A Resource Dependence Perspective*, Harper & Row Publishers, New York, NY.

Putnam, R.D. (1995), "Bowling alone: America's declining social capital", *Journal of Democracy*, Vol. 6, pp. 65-78.

Quinn, R.E. and Rohrbaugh, J. (1983), "A spatial model of effectiveness criteria: towards a competing values approach to organizational analysis", *Management Science*, Vol. 29 No. 3, pp. 363-77.

Robson, C. (1995), *Real World Research: A Resource for Social Scientists and Practioner-Researchers*, Blackwell, Oxford.

Schumpeter, J. (1934), *The Theory of Economic Development*, Harvard University Press, Cambridge, MA.

Scott, J. (1991), *Social Network Analysis: A Handbook*, Sage, London.

Sengupta, S. (1998), "Some approaches to complementary product strategy", *Journal of Product Innovation Management*, Vol. 15, pp. 352-67.

Simon, H.A. (1947), *Administrative Behavior*, Macmillan, New York, NY.

Sloan, A.P. (1963), in McDonald, J. and Stevens, C. (Eds), *My Years with General Motors*, Sidgwick & Jackson, London.

Spender, J.-C. (1996), "Making knowledge the basis of a dynamic theory of the firm", *Strategic Management Journal*, Vol. 17 No. 2, pp. 45-62.

Taylor, F.W. (1911), *The Principles of Scientific Management*, Harper Bros, New York, NY.

Townsend, R. (1970), *Up the Organization*, Alfred A. Knopf, New York, NY.

Trist, E.L. and Bamforth, K.W. (1951), "Some social and psychological consequences of the longwall method of coal-getting", *Human Relations*, Vol. 4, pp. 1-38.

Van de Ven, A.H. and Ferry, D.L. (1980), *Measuring and Assessing Organisations*, John Wiley, New York, NY.

Volberda, H. (1998), *Building the Flexible Firm: How to Remain Competitive*, Oxford University Press, New York, NY.

Wernerelt, B. (1984), "A resource-based view of the firm", *Strategic Management Journal*, Vol. 5, pp. 171-80.

Yin, R.K. (1994), *Case Study Research: Design and Methods*, Sage Publications, Inc., Thousand Oaks, CA.

Appendix

Company	Product	Turnover 2001, EUR	Employees 2001	Turnover 2002, EUR	Employees 2002
1. Position	Positioning software for wireless networks	400	10	63,000	17
2. Game	Branded mobile games and entertainment	550,000	40	500,000	25
3. Test	Software for automated software testing	111,000	7	550,000	22
4. Video coding	Video coding software for wireless telecommunication	100,000	50	1,000,000	55
5. Marketing	Software for mobile marketing	400,000	30	1,300,000	23
6. Messaging	Software products for mobile messaging management	2,000,000	60	3,000,000	80
7. Engine	Games engine software	7,200,000	20	5,600,000	25
8. Broadcasting	Broadcast content management software	6,000,000	70	6,000,000	70
9. Resource	Resource and project management software	7,000,000	80	8,000,000	75

Table AI.
The details of nine case companies

Social capital	Value system
Network ties – structural component:	*The level of determination of the value activities and actors*
We have got new contacts through the partner	How well-known are the value activities in the relationship?
We have participated in several events organised by the partner	How well-known are the capabilities of the actors performing the value activities?
The partner has "opened the door" for us.	How explicitly can these be specified?
Social interaction – relational component:	*The goal of the value system*
We maintain close social relationships with the partner	What outcomes are pursued through the network: e.g. increasing the operative efficiency of an established system or creating a completely new business and products?
There is high social interaction in the relationship	How future-oriented are these outcomes?
We know the partner's people on a personal level	*The structure of the value system*
We rather trust the partner's handshake than signed contracts	How complex is the network comprising actors, activities and resources exchanged?
Control through social relations – cognitive component:	How evolving is the structure of the network? (stable, incremental/radical, emerging)
Certain key people are important for the success of the relationship	What kind of changes and occurrences exist in network (stable, incremental/radical, emerging)?
Reciprocity is important in the relationship	
We solve problems rather by personal agreements than written contracts	
Both parties avoid making demands that can seriously damage the interest of the other	
The partner always keeps its promises	

Table AII.
Themes of value system and social capital used in the study

Table AIII.
Effectiveness variables used in the study

Human relations model	Open systems model	Internal process model	Rational goal model
Means: Cohesion, morale stability and initiative (Fayol, 1949) Motivation, *esprit de corps* (Fayol, 1949) Employee satisfaction (McGregor, 1960; Fayol, 1949; Likert, 1967) Openness (McGregor, 1960; Likert, 1967) *Ends:* Human resource development, organisational learning (Kale *et al.*, 2000; Lane and Lubatkin, 1998) Capability of co-operating, internal fit (Lorsch and Morse, 1974; Lane and Lubatkin, 1998) Capability of managing crisis (Larson, 1992; Volberda, 1998) New product innovations (Calantone *et al.*, 2002) Technological distinctiveness (Taylor, 1911)	*Means:* Flexibility, goal setting Controlled growth of operations (Chandler, 1962; Kazanjian and Drazin, 1990) Control of market uncertainty, implementation of change (Chandler, 1962; Krishnan and Bhattachraya, 2002; Lawrence and Lorsch, 1967; Hagedoorn, 1993) *Ends:* Growth, resource acquisition Structure/strategy congruence (Chandler, 1962) Organisation/environment fit (Lawrence and Lorsch, 1967; Brown and Eisenhardt, 1995) Customer-oriented focus (Peters and Warterman, 1982) Knowledge and resource acquisition (Nohria and Garcia-Pont, 1991; Larson, 1992) Enhanced industry reputation, customer trust, market visibility (Larson, 1992; Nahapiet and Ghoshal, 1998; Alvarez and Meyer, 1999) Competitive position (Lawrence and Lorsch, 1967)	*Means:* Information management, communication Change management, agility (Townsend, 1970; Lane and Lubatkin, 1998) Order, clear authority and discipline (Fayol, 1949) Quality control (Townsend, 1970) Efficient information processing, communication (Simon, 1947; Koka and Prescott, 2000; McGregor, 1960; Likert, 1967) Documentation of processes (Cooper, 1983) *Ends:* stability, control, congruence of internal processes (Trist and Bamforth, 1951) Protecting core assets (Kale *et al.*, 2000) Efficiency through economies of scale (Sloan, 1963)	*Means:* Planning and goal setting, product maximisation (Taylor, 1911; Hamel, 1991) Optimal use of resources (Taylor, 1911) *Ends:* Productivity, efficiency, Minimising costs and investments, particularly in core products and technologies (Taylor, 1911; Hagedoorn, 1993) Productivity (McGregor, 1960; Hamel, 1991; Likert, 1967) Return on investment (Taylor, 1911; Sloan, 1963) Profitability (Townsend, 1970) More focused business objects (Sloan, 1963) Sales growth through gaining market power (Sengupta, 1998; Pfeffer and Salancik, 1978)

Company	The complementary relationships of the case companies
1. Position	Position has established first relationships with four potential delivery channels, but they have not succeeded in entering into any agreements. The reasons for the emerging nature of the relationships are to be found in high dominance of potential partners and uncertain value chains in the mobile positioning markets
2. Game	Game has a delivery channel, but the relationship has started to decline because of reorganisations in the partner company. Game is a member of two industry forums aiming at developing new standards and innovations for the mobile industry
3. Test	The company has just recently undersigned a letter of intent with two leading testing tool companies providing delivery channels
4. Video coding	Video coding has established three OEM agreements with multinational corporations operating in mobile communication industry. The value activities performed jointly in the relationships also include marketing activities. The company is a member of two industry forums aiming at developing technological standards and innovations for mobile industry
5. Marketing	Marketing has recently made an agreement with a delivery channel located in Switzerland. Because of the short history, the relationship is only in engagement state. Marketing is a member of an industry forum and the object of the relationship is to gain sales growth through gaining market power
6. Messaging	Messaging has two OEM agreements with global mobile communications companies. The company develops a critical sub-component for the partners' messaging centre. The activities performed jointly in the relationships also include marketing support when necessary. Messaging has two delivery channels. The company is involved in R&D cooperation with three small software companies, in which R&D activities are performed jointly in the relationship by software developers. The object of the relationships is to develop complementary products and thus to offer customers better quality in terms of broader functionality
7. Engine	Engine has a sales partnership with a global company that is one of the world's leading publishers and distributors of video games
8. Broadcasting	Broadcasting has four sales partnerships with global companies. The main partnership involves a global IT company: broadcasting is a member of the Digital Media Factory portfolio, including only 20 selected partners. The other partners deliver, for example, media systems, networked audio devices, computer sound cards, and audio management software. Broadcasting has entered into a contract of R&D cooperation with a global mobile communications company. The nature of the cooperation is highly sophisticated and confidential, and the results of the cooperation will be announced in 2004.
9. Resource	Resource has partnerships with three technology suppliers renting extra resources for software development when necessary. Resource has three sales partnerships with three global companies delivering ERP systems. Resource has established R&D cooperation with their key customer. The company also cooperates actively with the other members of the conglomerate

Table AIV.
The details of network relationships of case companies

Dynamic Capabilities in Small Software Firms: A Sense-and-Respond Approach

Mathiassen, Lars & Vainio, Anu Marianne

Dynamic Capabilities in Small Software Firms: A Sense-and-Respond Approach

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Dynamic Capabilities in Small Software Firms: A Sense-and-Respond Framework

Small software firms find themselves in highly complex and turbulent environments that require dynamic capabilities to constantly build, integrate, and reconfigure resources. While the literature describes different types of dynamic capabilities that can help software firms adapt, there are no frameworks to study and manage such dynamic capabilities in this particular context. We present a sense-and-respond framework and use it to study two software firms, *Starter Inc.* and *Mature Inc.* In both firms, the sense-and-respond framework provided an integrated view of process-level and firm-level dynamic capabilities. On the process-level, it covered dynamic capabilities related to input, process, and output aspects of software development. On the firm-level, it provided an understanding of the mechanisms and structural conditions that shape dynamic capabilities within each firm. Moreover, the framework revealed variations in sense-and-respond practices as a reflection of differences in maturity between the two firms. We suggest on that basis that the sense-and-respond framework provides useful guidance to assess, design, and manage the dynamic capabilities needed in the high-velocity markets in which small software firms exist.

Keywords: software management, dynamic capability, organizational sense-and-respond behavior.

I. INTRODUCTION

Globalization, acute competition, new information technologies, and emerging customer demands are increasingly redefining business environments. These changes also affect the software industry where firms increasingly compete on price, quality, and performance of the delivered software. Gartner Research [1] predicts, for example, that manufacturing costs of mobile devices drop below 50$ per unit, effectively turning wireless and mobile devices into standardized commodity services. Given the multitude of technology suppliers in this industry, Gartner Research suggest that software firms increasingly will have to depend on integration and reconfiguration capabilities [2] to respond effectively to emerging customer demands. This trend is also seen in other industries [3] where value chains develop into integrated business networks that deliver value by matching the resources of the participating firms more efficiently and effectively to emerging and diverse customer demands. As a result, software firms today find themselves in highly complex and turbulent environments that increasingly require them to build, integrate, and reconfigure resources to adapt to emerging needs and opportunities.

This trend poses particular challenges for small software firms that develop services for the market or as suppliers to other software firms. Small software firms must adapt while being constrained by limited and tightly scheduled resources, predominantly fixed costs of service development, and often high dependence on one or a few large and powerful players within the industry. Small software firms are therefore extremely vulnerable to changes in technologies and markets. Moreover, given that resource limitations of younger companies make them prone to liabilities of newness and adolescence [4] it may be difficult to identify and develop effective approaches to reconfigure their resources. Finally, as higher marginal returns can be expected mainly from increases in market share because of initial development costs, small software firms can more easily deploy software services to different situations by abstracting knowledge to remove context specific elements. However, as they often depend on one or a few larger and more powerful players within the software domain their ability to adapt in this way is limited.

The resource-based view [5, 6] suggests that firms are heterogeneous entities differing in capabilities and resources [7]. Building on this view, firms are able to improve their competitive advantage by implementing value-creating strategies that cannot easily be duplicated by competing firms [6]. Moreover, the resource-based view suggests firms can develop dynamic capabilities allowing them to integrate, build, and reconfigure internal and external resources [8]. While the dynamic capability concept is broad and apply to all types of firm processes [9], we focus in this paper on those dynamic capabilities that help organizations adapt to changes in their environment.

The information systems and marketing literature offer several dynamic capabilities that are useful for small software firms. There are, however, currently no frameworks that can help these firms assess, design, and manage the dynamic capabilities needed to effectively respond to changes in customer demands, market opportunities, and emerging technology options.

We have therefore investigated how contemporary agility frameworks can be used to help manage small software firms in turbulent and unpredictable business environments [10, 11, 12]. More specifically, we have used Haeckel's sense-and-respond framework [12, 13, 14] to study the dynamic capabilities required by small software firms to respond to changes in the environment. The research was carried out as a deductive, multi-level case study [15, 16] of two small firms, *Starter Inc.* and *Mature Inc.*, and it contributes to the literature on software management. Our analysis of each firm allowed us to develop an integrated view of process-level and firm-level dynamic capabilities. A subsequent cross-firm comparison revealed important variations in sense-and-respond practices as a reflection of differences in maturity between the two firms. We suggest on that basis that the sense-and-respond framework provides useful guidance to assess, design, and manage the dynamic capabilities needed in the high-velocity markets in which small software firms exist.

The overall structure of the paper is as follows. First, we review insights from the information systems and marketing disciplines on dynamic capabilities for managing the relationship between software firms and their environment. Next, we present the adopted sense-and-respond framework together with propositions that guide our empirical exploration. We then introduce the rationale for and the organization of the underlying case study. Subsequently, we present the sense-and-respond analyses of the two case firms. Finally, we discuss the potential contribution of the sense-and-respond framework to assess, design, and manage dynamic capabilities in small software firms and we outline implications for both practice and research.

II. THEORETICAL BACKGROUND

Our research draws upon two bodies of knowledge. First, we review the information systems literature about software management and the marketing literature about new product development to identify relevant dynamic capabilities for managing the relationship between small software firms and their environment. Second, we consider the agility literature and present the sense-and-respond framework that we adopt in this study.

A. Dynamic Capabilities in Software Firms

Complex and turbulent markets requires software firms to be highly adaptable. Eisenhardt and Martin [15, 17] define this kind of high velocity markets as ones in which market boundaries are blurred, successful business models are unclear, and market players are ambiguous and shifting. Within such unclear and unpredictable industries, a major source of sustained competitive advantage is the dynamic capabilities by which a firm 'integrates, builds, and reconfigures internal and external competencies to address rapidly changing environments' [8, 17].

Researchers have argued for a variety of flexible organizational solutions that can help firms adapt to changing conditions [18, 19]. In particular, the software management and new product development literature suggest specific dynamic capabilities that are useful for software firms. In the following, we review these insights based on a view of software development and management as an open system that interacts with the environment through its inputs, processes, and outputs. First, we look at insights from the literature that suggests how knowledge is created and shared (input). Second, we consider insights on how to configure and manage development of software services (process). Third, we look at contributions on how to design and structure the resulting software services (output).

The first stream of literature focuses on the input to software development. Since this is a knowledge-intensive activity, management of knowledge resources is especially critical for software firms: generating and exploiting knowledge in high-technology sectors demands that knowledge is continually replenished [20, 21, 22]. As Mata et al. [23] summarize, successful firms increase flexibility by fostering a culture of communication and functional integration. Knowledge creation and sharing are likely to lead to greater degrees of integration between functions. Limited interaction, in contrast, can lead to ills and fallacies and an inability to discover the complexity of a given product or service domain. Current information systems approaches, unfortunately, often focus on particular customer projects and they adopt a technological perspective and neglect interactions with other business dimensions and the external environment [24]. Customers and users are important sources of innovation and firms are therefore encouraged to commit considerable resources to build sustainable, long-term customer relationships [25, 26]. To gain competitive advantage, firms need to understand customers and markets and integrate this knowledge appropriately with technical knowledge. Although the need for effective communication amongst relevant stakeholders is widely recognized and supported on the process-level of software development [27, 28] we have found no approaches to firm-level design that can

help small software firms manage knowledge creation and sharing efforts in response to changing customer and market needs.

The second stream of literature is about configuring and managing the process of developing software services. Some researchers have emphasized a well-structured process [29], arguing that by executing software development with incremental commitments and suitable development methods, firms can increase adaptability. A complete and disciplined product development process enhances the utilization of information and the effectiveness of decision-making [30, 31, 32] thus establishing the necessary structures for dealing with the uncertainty of the external environment. Moreover, key activities such as screening, market research, customer trials, and market launch should not be forgotten, as the balance between market-oriented and technical activities is important [33]. In particular, collecting, interpreting, and internalizing technological and marketing capabilities from past projects and incorporating that knowledge in a systematic and purposeful manner into new projects increase product development success and long-term competitive advantage [34].

The software literature has also approached the need for lighter, nimbler, and flexible development practices [35, 36, 37, 38]. Some authors [39] claim that these agile approaches share fundamental software development principles with traditional methods. Proponents of agile approaches argue, however, that traditional methods are too mechanistic and rigid to cope with current business demands. Instead, they propose to configure and manage development processes based on values such as: individuals and human interactions over processes and tools; working software over comprehensive documentation; intense customer collaboration over contract negotiation; and, responding to change over following a plan [40]. Agile approaches recognize people as the primary drivers of project success, they focus intensively on effectiveness and maneuverability, they suggest to use the best architectures, requirements, and designs that emerge from self-organizing teams, and they consider change management to be a key discipline [37, 41]. However, comparative analysis of agile approaches suggests that life-cycle coverage remains partial, comprehensive support for project management is missing, emphasis should be placed on enabling organizations to utilize the suggestions made, and more work is needed on how to adopt agile approaches in different organizational contexts [40]. As [42] suggest, there is a need to develop forms of software development that integrate process-level and firm-level capabilities to respond effectively to uncertainty and unpredictable change.

The third stream of research focuses on the output from software development activities. This stream provides insights into how component-based approaches can help achieve short

development cycles and flexible software [43, 44]. A component-based software architecture implements a collection of common elements, particularly the underlying technology elements, across a range of services and technologies allowing desired individual features and application functions to be rapidly configured for specific customer requests [26]. This approach to product portfolio management helps a firm reduce the cost of developing individual product variants thanks to reuse of a common product platform [45]. Other research [46] have focused on facilitating market-oriented development by increasing dependence on packaged software. Although component-based approaches improve a firm's capability to respond in a profitable and timely way to emerging customer and market needs, these approaches primarily target the structuring of the software itself rather than the organization of the firm that develops and innovates the software. Software architectures can, however, be viewed as coordination mechanisms to divide work in a project or a firm [47]. The relationship between software architectures and enterprise architectures as enablers of dynamic capabilities is therefore an interesting avenue for exploration.

Small software firms need dynamic capabilities to adapt to changes in the environment. These capabilities help them identify relevant signals in their environment, evaluate how signals relate to each other and affect existing and future products, and design and prioritize appropriate responses to these signals. Sheramata [48] suggests, in general, that product development firms that only generate and integrate knowledge to develop products as responses to given problems are less successful in attaining their goals than firms that actively search to identify new problems and opportunities. Dynamic capabilities should therefore help small software firms process increasing amounts of information about demands and opportunities through continuous interaction with their environment. For a new or small venture with limited resources, it is a challenge to develop and sustain such dynamic capabilities. The literature provides, as we have seen, a portfolio of potentially relevant dynamic capabilities that small software firms can use to resolve specific issues related to the input, process, or output of their activities. We have, however, found no approach that can help them integrate these ideas into coherent organizational designs under the constraints of limited and tightly scheduled resources, predominantly fixed costs, and typical high dependence on a few large players within the software industry.

B. A Sense-and-Respond Framework

To survive and be successful in turbulent business environments firms must [10, 11, 49]: 1) respond to anticipated and unexpected changes in proper ways and due time, and 2) exploit changes and take advantage of change opportunities. This implies having 'change competency' [50], being 'proficient at change' [10], or exercising 'appropriate and systematic organizational

response to change' [12]. Depending on the approach taken, firms with this capability are called 'agile' [10, 11, 49] or 'adaptive' [12]. Agile firms have transformed their culture, strategy, and governance to practice a new sense-and-respond mindset [12] and they have learned to manage and apply knowledge effectively to thrive in a continuously changing and unpredictable business environment [10]. Agility is in this way enabled by the specific subset of dynamic capabilities that firms use to respond the changes in the environment [9].

The focus of agile firms is still on revenues and profitability, but the source of profit shifts from economies of scale to economies of scope [10, 11, 14]. The strategy shifts from mass production to mass customization. Reuse of modular processes and products that can be rapidly configured in response to a wide range of demands and opportunities makes it possible to achieve both profitability and flexibility [14]. However, this requires integration of process-level as well as firm-level innovations into a coherent sense-and-respond system [51]. On the process-level, each key process must have the ability to learn, i.e. sense and respond appropriately to changes in the environment [10, 12]. On the firm-level, different responses need to be prioritized and coordinated and resources need to be dynamically committed to activities as priorities change [10, 12]. Agility is hence a combination of a highly distributed capability that leverages the impact of people and knowledge throughout the firm [11, 12, 52] and a systemic capability that coordinates responses and re-organizes resources across the firm [51]. Empowerment to increase creativity and innovation [11] and enhanced use of information systems and technologies [53, 54] are therefore key facilitators of business agility.

Different firms experience different changes and different levels of pressures, and therefore require different combinations of practices and tools to cope with their environment. For instance, the type of product a firm provides [55] and the maturity of a firm [10, 56] affect the selection of appropriate agility practices. Thus, it is important to study how agility can be developed across types of firms within specific industries.

Sharifi and Zhang [49] present an approach to agility in manufacturing organizations. Their conceptual model [57] has three constituting elements: agility drivers, agility capabilities, and agility providers. Two cases of adopting the approach suggest that it can help firms formulate strategic policies and conceptualize the meaning of agility. Nevertheless, the approach still needs improvements, especially in defining the relationships between capabilities and practices [49]. Furthermore, the approach considers the level of a firm's agility from no-need to high-need as opposed to other approaches [10, 13] that argue that agility is a core capability required by all firms in today's business environment.

Dove [10] offers an enterprise model of how a firm can become agile. This approach suggests that agility is derived from both the physical ability to act (response ability) and the intellectual ability to find appropriate things to act on (knowledge management). The central design attribute is the concept of loosely coupled interacting components that are reconfigurable within an organizational framework. Hence, change enabling organization is based on small, interacting, self-organizing, autonomous units, such as process modules, product components, and reconfigurable resources. A change proficiency maturity model is also proposed to help evaluate how well a firm is capable of addressing change. Real-life case studies are provided to demonstrate how various change issues are dealt with using these practices.

Haeckel [12, 13] suggests a sense-and-respond framework that requires recasting strategy, structure, and governance. Strategy becomes a design for action, rather than a plan of action; structure becomes a network of modular, collaborative capabilities, rather than a static hierarchy of tasks and responsibilities; and governance is no longer command and control, but context and coordination focused. Haeckel provides several case examples, but none of them represent the particular situation that small software firms find themselves in [12, 13, 14]. In the following, we review Haeckel's framework in more detail.

On the process-level, the emphasis is on response-ability [10] implemented through sense-and-respond cycles for a firm's key processes. This four phase adaptive cycle [12] is illustrated in Figure 1.

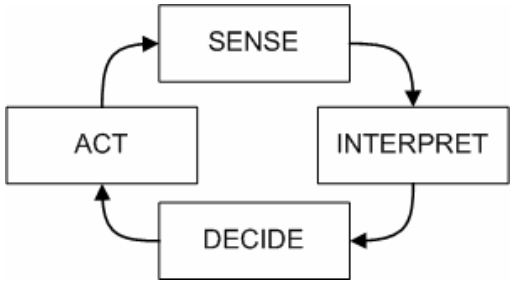

FIGURE 1. THE ADAPTIVE LOOP [12].

According to [12], adaptive organizations first sense changes in their environment and internal activities. They next interpret these changes in the context of their experience, aim, and capabilities, separating threats from opportunities and discarding irrelevant information. Next, they decide how to respond and, finally, they implement their decisions. The progression from sensing to interpretation to decision to action becomes an iterative loop that monitors the results of previous actions and picks up environmental changes that have occurred since the previous cycle. Of course,

all signals can not be sensed and responded to. Decisions are therefore crucial in determining where organizations choose to place their antennas and how they distinguish relevant signals that affect their success [12].

On the firm-level, the emphasis is on systemic management. The purpose is to create a context in which all members of the organization know how and why activities are executed; in which coordination is provided through shared values and through a uniform language that is spoken across the firm's modular processes; and, in which matching of products and services to current customer preferences and values is facilitated by reconfigurable repertoires of capabilities [12, 13, 14, 51]. The systemic approach to management integrates process-level sense-and-respond cycles with firm-level mechanisms and structural conditions that offer autonomy and independency to act while at the same time maintaining integrity and coordination. This firm-level approach is summarized into four principles for agile enterprise design [13]:

- *Processes that learn.* Learning can occur individually, collectively, or institutionally and the firm should complement key business processes with sense-and-respond cycles as illustrated in Figure 1. These cycles capture and interpret signals from the environment and determine when and how information, procedural models, and commitments should be changed. Often, technology is used to increase learning.
- *Value-based governance.* The firm should enable local autonomy to act within each sense-and-respond cycle while at the same time ensuring overall coordination across cycles. This requires three elements. First, the firm should articulate principles that in simple and clear terms communicate the purpose of business and the values that define what people are expected to do and not to do. Second, the firm should define and assign responsibilities for the key activities required to realize the purpose of business. Lastly, in dynamic environments, it is important to consider how governance principles are updated, and how they become embedded in the practices of the firm.
- *Dynamic personal accountabilities.* Business processes have two dimensions: procedure and accountability. Procedures define what needs to be done to what and with what. Accountabilities define who owes what to whom and by when. Accountabilities are in this way the protocols through which processes are enacted. To be able to respond effectively to changes in the environment, the firm must be able to dynamically create and recreate the network of commitments between people.

- *Modular processes and products.* Mass customization is the ability to produce tailored responses at a cost as low as if the company were mass producing a product or service. Modular products or services facilitate mass customization and modular processes make it easier to quickly snap together solutions that meet specific customer demands.

In the following, we adopt Haeckel's sense-and-respond framework to explore how small software firms can survive and thrive in complex and turbulent environments. Haeckel's framework allows us to analyze both individual instances of sense-and-respond behavior on the process-level as well as firm-level issues related to a firm's structure and management practices. Second, this framework offers a process-level cycle and firm-level principles for identifying and evaluating sense-and-respond behavior. Hence, it leans itself well towards empirical explorations of agility practices in firms. Third, compared to the other frameworks, it is particularly straight-forward in giving guidance on how to assess, design, and manage dynamic capabilities. The framework has therefore considerable potential as a tool for software managers. Finally, this framework has not yet been explored in the context of small software firms.

For these reasons, this study is designed to explore the following research question: How can the sense-and-respond framework be used to assess, design, and manage the dynamic capabilities in small software firms? We approach this question empirically by applying the sense-and-respond cycle and the four principles to identify, understand and explain dynamic capabilities in two small software firms. Based on the discussion above, this empirical exploration is guided by the following propositions:

- Proposition 1: The sense-and-respond framework provides an integrated view of process-level and firm-level dynamic capabilities in small software firms.
- Proposition 2: The sense-and-respond approach reveals differences in dynamic capabilities between immature and mature small software firms.

III. RESEARCH METHODOLOGY

The research was designed as a deductive, multi-level case study to explore how two small software firms design and manage dynamic capabilities in response to events in their environment. To focus the study and to help shape data collection and analysis [58, 59], we deductively employed Haeckel's sense-and-respond cycle, his four principles, and Propositions 1 and 2. This approach helped us create a firm empirical grounding for suggesting conclusions. The two-level research design allowed us to investigate sense-and-respond practices on a process-level while at the same time considering the firm-level mechanisms and conditions that shape these practices.

The how-nature of our research question combined with the focus on contemporary events in small software firms suggest a case study approach as appropriate [16]. This allowed us to study dynamic capabilities within the real-life context of the two small software firms. Overall, we adopted an interpretive case-study approach [15] by accessing the meanings that participants in the two firms assigned to their social context. This allowed us to investigate not only how members of the two firms acted, but also why they acted as they did in response to changes in their environment [59, 60]. To implement this research design we followed Yin's advice and developed a comprehensive study protocol [16], see Appendix I.

A. Case Selection and Data Collection

Case studies focus on understanding the dynamics within one or more social setting [16, 58]. The approach includes different data collection methods and provides many sources of evidence to help reach a deep understanding of the phenomenon under investigation and ensure satisfactory validity of the findings [16, 58]. Like in other studies [61, 62, 63], our case selection was based on replication logic to obtain information from comparable cases. Replication adds confidence and robustness to the findings, but it does not ensure generalizable results [16, 64]. We selected two small, Finnish software firms that both sought growth based on initial venture capitalists' investments. The two firms operated in similar contexts and had similar goals, but they were in different stages of development. Hence we adopted literal replication [16, 64] hoping to find similar results across the two cases (exploring Proposition 1) and combined it with theoretical replication [16, 64] hoping to find contrasting results between the two firms (exploring Propositions 2).

We identified two firms that were competent in integrating and reconfiguring resources in response to dynamics in their environment. From 2002 to 2003, the yearly growth in turnover of both firms varied from 100% to 150%. Also, the number of customer accounts, the size of the organization, and the funding from investors increased yearly in both firms. These indicators suggest that both firms were capable of responding effectively to environmental demands. The literature suggests that the maturity of a firm affects its agility practices [10, 56] as expressed in Proposition 2. We therefore identified two firms on different stages of business development. One firm, *Starter Inc.*, was a recent start-up, and the other, *Mature Inc.*, was a mature, but still small software firm.

To ensure rich data from the two firms and to facilitate triangulation, we collected evidence from four sources within each firm [16, 64]. First, we acquired written material including brochures, annual reports, internal documents, and trade journal articles about the firms. Secondly, we used archives such as marketing presentations, organizational records, project documentation, and

customer records. In doing so, we kept in mind that the documents stated the interpretations of actions in the firms rather than unmitigated truth [16]. Third, we used observation through site visits. One of the authors visited each firms six times and made observations of meetings, locations of work activities, and normal office communications. These observations were recorded through elaborate field notes and they provided valuable information about organizational arrangements and practices. Finally, we conducted four types of theme interviews in each firm as the use of multiple respondents enhances the creative potential of the study and builds confidence in the findings [64], see Appendix II. A total of 20 interviews were conducted across the two firms. Initially 5 interviews were conducted in each firm to collect data. Subsequently, after initiation of data analysis, we conducted 5 follow-up interviews in each firm to clarify uncertainties and provide additional data. The initial interviews lasted between 1.5 and 2 hours. The follow-up interviews lasted about 1 hour.

To begin with, the CEO (at *Starter Inc.*) and the head of business development (at *Mature Inc.*) were interviewed on why and how environmental signals were sensed and interpreted, and on how responses were designed and decided upon. During a subsequent visit to the two firms, the same respondents were interviewed to answer questions focusing on management, business development, and marketing practices. These key informants then suggested project managers involved in practical operations within each firm. These managers were interviewed about projects and activities they were involved in. Finally, the head of software development or the head of technology were interviewed about software development practices. All interview types helped us analyze how internal practices supported sensing and responding to events in the environment both on the process- and the firm-level.

In all interviews, the stream of questions was fluid rather than rigid [65] and the interviews were of an open-ended nature. However, to ensure sufficient support for exploring our research theme we focused on questions derived from the study protocol [66]. The interviews were tape recorded and notes were taken simultaneously. The use of multiple sources of evidence allowed us to address a broader range of historical, attitudinal, and behavioral issues. In particular, the two written sources of evidence were helpful in corroborating and augmenting evidence from other data sources. For example, we systematically compared project documentation with interview data to verify specific sense-and-respond capabilities. This made it less likely that we were misled by single sources and it helped us be critical in interpreting the contents of each source of evidence.

B. Data Analysis

The purpose of data analysis was to offer knowledge regarding the applicability of the sense-and-respond framework to assess, design, and manage dynamic capabilities in the two software firms. Hence, we identified and evaluated sense-and-respond behaviors and mechanisms in each of the two firms with particular emphasis on interactions with the environment. In a first rough analysis, we studied financial information from 2000 to 2003, future estimates for 2004, strategy and operating plans, organization structure, and product white papers to focus and plan the detailed data collection through interviews and site visits. Then, in line with [16, 64] we analyzed the interview data and other data sources from different perspectives as summarized in Table A. First, guided by Proposition 1 we conducted a within case analysis of sense-and-respond mechanisms and behaviors in each firm. On the process-level, we carried out a theory-driven [64] analysis of sense-and-respond episodes in each firm using Haeckel's cycle [13]. Subsequently, on the firm-level, we identified enablers and barriers for sense-and-respond behavior across the identified episodes. This analysis helped us understand the structural conditions that shaped sense-and-respond behaviors in the two firms. Second, guided by Proposition 2 we conducted a theory-driven, cross-case analysis [64] using Haeckel's systemic principles to compare and contrast sense-and-respond mechanisms and behaviors across the two firms. The initial within-case analysis helped ensure a solid foundation for this cross-case comparison.

TABLE A. STRATEGY FOR DATA ANALYSIS

Proposition	**Cases**	**Theme**	**Level**
Proposition 1	*Within-case analysis*	*Sense-and-respond episodes*	*Process-level*
		Sense-and-respond enablers and barriers	*Firm-level*
Proposition 2	*Cross-case analysis*	*Sense-an-respond principles*	

In line with [16, 64], this systematic approach to specification of conceptual framework, propositions, case selection, data collection, and data analysis made it possible to develop a theory-driven analysis of dynamic capabilities for managing the relationship between the two firms and their environment. The analysis is presented below and it forms the basis for the subsequent discussion of our research question and findings.

IV. SENSE-AND-RESPOND ANALYSES

The two software firms operated in the mobile and wireless markets and both had a number of references. The customer segments of the two companies consisted of component suppliers, device

manufacturers, operators, and service providers. Both companies offered licenses, consultation, implementation services, and support. However, the companies differed from one another in terms of business development stage. *Starter Inc.* was a start-up company that had recently begun to commercialize the first version of a product. *Mature Inc.* had already launched four product versions over six years.

Below, we present the results of the within-case and cross-case analyses summarized in Table A. The selected episodes cover dynamic capabilities related to how new customer, market, and technology knowledge is created and shared (input); how development of software is configured (process); and, how software is designed and structured (output). These episodes show how the firms adapted to the environment through cycles of sensing-interpreting-deciding-acting [13], cf. Figure 1. For each episode we identify enablers and barriers for sense-and-respond behavior to understand the firm-level mechanisms and structural conditions that shaped dynamic capabilities within each firm. Finally, we present a cross-case analysis of how Haeckel's systemic principles for agile enterprise design [13] were implemented in the two firms.

A. Starter Inc.

In 2003, the turnover of *Starter Inc.* was 2,5 million euros and it had 62 employees. The firm was just about to reach breakeven and the estimated turnover for 2004 was five times higher. The product was a complete system incorporating all the technology required for implementing video applications for mobile devices ranging from cellular phones to digital cameras. At this point of development, *Starter Inc.* had only delivered a few licenses to customers. Table B provides a summary of the process-level analysis of sense-and-respond episodes at *Starter Inc.*

TABLE B. SENSE-AND-RESPOND ANALYSIS OF *STARTER INC.*

Episode	Sensing	Responding	Enablers (E) and barriers (B)	Outcomes
Developing fast response to customers	*Low speed in customer projects*	*They engaged in developing a new product architecture. When a customer placed an order, the product was already 90% ready. The remaining 10% consisted of tailoring components into a final product*	*(E) A modular product architecture* *(B) Although the architecture helped separate concerns and employ optimal solutions, high coupling between modules caused extensive tailoring* *(B) Developer team processes were not aligned with the new architecture* *(B) No product managers to coordinate resource allocation because the hierarchy of key accountabilities was not defined*	*Increased interoperability and integration among existing components* *Teams adopt architecture on ad-hoc basis because of lack of coordination* *Focus on action, rather than interaction and accountabilities* *Management group works as account manager to deliver response*

Designing interactions with external environment	*Enhancing competitive position against other players*	*They modelled the relationships to their partners and competitors to develop better relations and interactions*	*(E) Focus on interactions, rather than actions to dynamically create their network of commitments* *(E) Extending modular thinking beyond company borders* *(E) Interactions enabled by Internet services, video, and e-mail* *(B) Hesitation to emphasize and insist on company values* *(B) Lack of resources and skills to forecast competitor moves because of inabilities to analyse data and use technology to collect data*	*Product and service positioning in the business network* *Basing product thinking on larger business network* *Difficulty updating governance mechanisms*
Interacting with customers	*Problems in selling their product*	*Based on customer preference, they developed face-to-face meetings and communication as a complement to existing excellent digital communication options*	*(E) Facilitating interactions through improved relationships and shared values* *(B) Unclear product positioning and value proposition* *(B) Incoherent values set boundary conditions and make interactions ambiguous*	*Increased synergy and performance of partnerships* *Decision to improve relationships did not help communicate benefits in clear and simple terms to customers*
Managing customer diversity	*Problems in scaling their business*	*The management group continued to assign tasks on ad-hoc basis as new needs emerge. The managers found it difficult to delegate responsibility.*	*(B) A lack of ability to delegate response ability* *(B) Centralized management group bottleneck towards scaling business activities*	*The current structure became increasingly inappropriate for controlling diverse and complex business needs* *The management group was not able to implement their decision and they had difficulty hiring new, competent managers* *Employee initiatives were restricted by centralized hierarchy*

The first episode demonstrates how *Starter Inc.* sensed low speed in customer projects, interpreted this to be caused by the software architecture, decided to develop a new architecture, and immediately implemented it. "*We now have 20 to 30 modules, of which 2 to 10 are implemented in a final software product. The purpose is that 90 percent of the work has been completed when a customer places an order. The rest of the work consists of tailoring the product according to a customer's needs and we try to complete this customization during a month,"* said the CEO. However, high interdependency (coupling) between the product modules still caused difficulties when tailoring the software to specific customer needs. In particular, due to evolving markets developers were constantly updating existing modules and developing new features. "*We have developed each of the modules approximately 5 to 8 times,"* noted the CTO. Additionally, each developer team adapted the new architecture to customer needs on an ad-hoc basis rather than following a systematic process. "*Although documentation and version management is appropriately completed, this is still a praiseworthy chaos,"* summarized the CEO. The

architecture was therefore at this point not effectively exploited as a mechanism to coordinate work in projects [47].

The second episode shows how *Starter Inc.* sensed constant changes in the external environment, interpreted a need to enhance its competitive position against other players, decided to focus on customer interactions rather than internal actions, and created a model to develop better relations to partners and competitors. The episode demonstrates how the firm designed and managed interactions in their business network to gather knowledge and reposition products and services. These interactions were enabled by Internet services and video and e-mail exchanges with customers and partners capturing requirements and opportunities to leverage partnerships and enable, augment, and extend firm capabilities. However, *Starter Inc.* did not explicate what people should do and not do. For example, they had not segmented their customers, established a revenue model, or developed product and service definitions. Instead, actions seemed to evolve with the environment. The resources and skills to analyze the market were informal and in most cases insufficient. Market analysis and decision-making was based on *"intuition, tacit knowledge, and informal discussions with potential customers, colleagues, and friends"* according to the CEO. As a result, *Starter Inc.* had developed some good relationships, but so far no big deals had materialized.

The third episode illustrates how the management group sensed inefficiencies in communicating the product definition and its benefits to customers, interpreted this to be caused by misunderstandings, and decided to invest in face-to-face customer interactions. So far, most exchanges with customers had been enabled by teleconferences and e-mail. However, despite increased face-to-face interactions, the management group continued to experience difficulties and their message remained inconsistent. They did not develop any marketing material and white papers to illustrate and conceptualize the product and its benefits. Additionally, the customers were located in Asia and the cultural differences affected the communication. The CEO expressed the inconsistency: *"We don't have any established business model. Instead, depending on a customer, we use all kinds of combinations. And because of the current state of the video application markets, the product definition evolves with each passing day ... We are just ramping up our sales. Related to that, we are currently trying to hire a new marketing manager. He should help us write the necessary brochures, white papers, and that kind of stuff."* Because the management group did not explicate the purpose and values of their business, they continued to have difficulties communicating products and services to customers.

The forth episode shows how the management group sensed problems in scaling the business and interpreted the need for new process and management capabilities. They tried to re-configure software development processes; but they had difficulties identifying and implementing effective approaches. Their existing governance mechanisms did not offer sufficient guidance for what needed to be done. The firm had neither organization charts nor role descriptions. As a consequence, the centralized management group could not delegate response ability to other actors within the organization. The CEO characterized the situation as follows: *"We get together with the right people [the management group] four times a year. Last time we rented a cottage in Lapland for a weekend. We discussed whether we did the right things and did not leave back home until we were sure about that."* The management group continued in this way to adopt ad-hoc solutions to perceived management challenges.

As we move to the firm-level, the identified sense-and-respond enablers and barriers provide important insights into the mechanisms and structural conditions that shaped *Starter Inc.*'s dynamic capabilities. The first and fourth episodes indicate that the governance mechanisms did not effectively provide context and coordination for teams to act independently. Although the firm had employed a modular architecture, the organization did not possess the mass customization capability needed to reconfigure processes and resources cost-efficiently. For example, the team structure was not aligned with the architecture, there were no product managers coordinating configurations of product components, and the management group lacked the ability to empower key employees. Learning was mainly limited to one centralized sense-and-respond cycle within the management group. Additionally, the second and third episodes show that *Starter Inc.* had difficulties explicating governance principles leaving the question of which values regulated the boundary conditions of the operation unanswered. While the emerging focus on electronic and face-to-face interactions helped the firm increase the synergy and performance of its partnerships, it remained a challenge to diffuse new product thinking into the business network to engage both existing and new customers.

B. Mature Inc.

In 2003, the turnover of *Mature Inc.* was 5 million euros and it had 65 employees. The turnover was estimated to grow approximately 20-30% the following year. *Mature Inc.* had developed a middleware solution enabling mobile operators to manage provisioning, delivering, and charging of wireless content services. The firm operated equally across the supplier, device manufacturer, operator, and service provider segments. Table C provides a summary of the process-level analysis of sense-and-respond episodes at *Mature Inc.*

TABLE C. SENSE-AND-RESPOND ANALYSIS OF *MATURE INC.*

Episode	Sensing	Responding	Enablers (E) and barriers (B)	Outcomes
Matching competencies and customer requests	*Customer request*	*The account manager negotiated commitments and prepared an offer. With the help of a project manager and the technology department, he planned how to adapt existing products and services to create a customized response to the request*	*(E) Business proposition was expressed as systems reuse. Modules were independent and couplings between them was simple and explicit* *(E) The account manager took the role of a dispatcher managing interactions* *(E) The company had explicit governance mechanisms that helped the account manager to set the boundaries for the negotiation with the customer* *(E) Customization was facilitated by the firm's intranet facilities, phone, and e-mail* *(B) The company had inadequate coordination in terms of resource allocation policies. This could slow down the creation of a response*	*The account manager created a tailored response to a customer request* *Possibility that a customer was not satisfied with the results but was then willing to wait for another iteration*
Developing modular product offerings	*Need to strengthen the company's position and sales*	*The firm developed a new product interface by connecting their existing product to their OEM customer's product*	*(E) Modular product architecture which could easily be enlarged by adding new interfaces* *(E) Guided by learning mechanisms and enabled by server-based information sharing across firm boundaries* *(E) Coincident values with a partner enhanced mutual knowledge exchanges as there was no ambiguity between the two firms* *(E) Contracts and documentation formed a basis for collective values and boundaries for negotiation*	*Enlargement of modular product architecture - complementary product integration*
Addressing market dynamics	*Lack of customers interest*	*Management learned what their customers needed by conducting an extensive market survey for key customers and partners*	*(E) Accessing customers to know their needs earlier* *(E) Analysing existing customer data to appreciate their customer needs* *(E) Using internet technology to collect information from geographically extensive areas* *(E) Learning cycle as guidance for the process* *(E) Aligning governance principles with market trends by emphasizing and insisting on company values*	*A model consisting of the current market situation, future trends, and the timing of those trends. The model helped update governance mechanisms* *Communicating benefits in clear and simple terms to customers*

Interacting with customers	*Misunderstanding software requirements*	*The project team tried to facilitate communication with customers by elaborating tools for conceptualization and visualization*	*(E) Using technology to facilitate communication and negotiation* *(B) Developers focused on action, rather than interaction* *(B) The accountabilities of a customer appear somewhat tacit. Different objectives, values and beliefs of stakeholders led to divergent interpretations*	*Practical use of a working, functional prototype to support interaction* *Limited support for interactions with a customer* *Weaknesses in stating guiding objectives and values to all project stakeholders* *Difficulty connecting to customer decision-makers and knowing their success factors because of a lack of open discussion*

The first episode shows how *Mature Inc.* sensed customer requests, interpreted customer needs, and decided to adapt existing products and services to create customized responses. An account manager worked as a dispatcher by snapping together offers based on existing products and services. In doing so, the account manager used up-to-date information about products and services available on the firm's intranet and interacted with customers supported by phone and e-mail. Software teams were subsequently able to deliver by leveraging the modular product architecture. If a customer was not immediately satisfied with a response, a new iteration was executed. The process was generally efficient as the team structure reflected the software architecture by having each team be responsible for specific modules. However, there was sometimes inadequate coordination of resources which could slow down responses.

In the second episode, *Mature Inc.* sensed a need to strengthen the firm's position and sales, interpreted this to be caused by customer requirements for software interoperability, and decided to enhance the product architecture by adding interface capabilities. The firm set up a co-operation project to integrate its product with other products. This episode demonstrates how modular thinking was extended beyond the firm's borders, as *Mature Inc.* entered into an OEM relationship and developed external modules for integration with a partner's software. In doing so, the two companies configured a shared development server that enabled collaboration and information sharing across firm boundaries. With customers placing considerable emphasis on cross-product integration, this episode illustrates how the success of a small firm can depend on its ability to integrate its products with relevant complementary products [67]. Doing so, the firm gains enhanced market visibility, product repute, and customer trust [68, 69]. The head of business development said: "*Messaging management is nowadays increasingly complex. Our messaging broker is highly networked software why we have to guarantee the interoperability with several other systems. Additionally, we want to focus on our core competence and therefore we are not going to develop every single module ourselves.*"

The third episode offers an example of how *Mature Inc.* sensed lack of customer interest in new products, interpreted this to be caused by bad timing, decided to increase market and customer awareness, and therefore initiated market surveys of key customers and partners. The market surveys were supported by Internet service that allowed respondents easy access to questionnaires and guidelines. Also, this approach enabled collection of standardized information and adoption of electronic procedures to process results. Management attempted in this way to enhance the flexibility of its offerings in relation to shifting customer demands by developing a model to appreciate and forecast market fluctuations. The head of business development said: *"We wanted to study the current market situation, the future trends, and the timing of those trends. On the basis of the results, we adjusted our plans. We will repeat this research yearly."* In doing so, management exploited technology to collect, interpret, and analyze data to help augment the firm's capability to adapt quickly to new demands and opportunities.

The fourth episode illustrates how a project team sensed misunderstandings, interpreted them to be caused by insufficient communication with the customer, decided to adopt interactive tools for conceptualization and visualization, and implemented specific groupware to facilitate customer interaction and prototyping. The episode demonstrates how the team adopted networking to interact more effectively with customers. Networking was in this way used to manage personal accountabilities and share insights across stakeholders, including customers. The team found that involving customers in generating ideas and testing concepts and products added significant value. The interaction was facilitated by technology, such as mock-ups, prototypes, and demos [47, 70] made available to the customer over Internet services. Also, the team subsequently collected information from the customer using e-mail in addition to phone and face-to-face interactions. However, the project team found it difficult to assign accountabilities to the customer. Said the project manager, *"although a customer is committed to having a software product, they are not so willing to work for it. It is quite difficult to assign responsibilities to [the customer]. In a way, they pay us for taking care of the project. And if they are not motivated to co-operate, as a small firm, it is very difficult to make any demands on them."*

Considering the enablers and barriers for sense-and-respond behavior, this analysis provides firm-level insights into the mechanisms and structural conditions that shaped *Mature Inc.*'s dynamic capabilities. The analysis suggests that the firm was able to fit and develop core resources to emerging customer requests and market opportunities. The firm had successfully adopted modular processes and products and knowledge exchanges with specific customers were enhanced by a dispatcher and enabled by technology. The firm also successfully developed relationships with a

partnering firm that allowed them to create new software integration capabilities, and they initiated systematic research activities to manage the portfolio of products and services in relation to relevant market dynamics. These initiatives were enabled by various forms of technology. However, as seen in the first episode, coordination and re-allocation of resources was somewhat problematic and could slow down responses. Also, as seen in the fourth episode, project managers sometimes found it difficult to ensure effective communication with customers. This was partly caused by some developers being more focused on developing software than interacting with customers. Another reason was differences in objectives and values between the firm and its customers. That led to divergent interpretations, inability to involve the appropriate decision-makers within the customer organization, and actively commit them to improved project progress.

C. Comparison

In the following, we complement the analyses of each firm with a comparison of how Haeckel's systemic principles for agile enterprise design [13] were implemented in the two firms. This analysis is summarized in Table D.

TABLE D. SENSE-AND-RESPOND COMPARISON BETWEEN *STARTER INC.* AND *MATURE INC.*

Capability	Starter Inc.	Mature Inc.
Processes that learn	*One centralized learning cycle with permanent functional representation and subsequent decentralized response implementation.*	*Several autonomous, but coordinated learning cycles with partly overlapping responsibilities and a combination of permanent functional and ad-hoc representation.*
Value-based governance	*Governance was enacted by centralized decision making and delegation of specified responses. The guiding values were not explicated but embedded into the central management group.*	*Governance was enacted through intensive networking, internally across functions and externally with customers and partners. The guiding values were explicated, communicated, and shared across the firm.*
Dynamic personal accountabilities	*Employees were re-assigned to new tasks on an ad-hoc basis to implement responses to emerging needs as a result of management group decisions.*	*Accountabilities were re-negotiated and adjusted to enhance sense-and-respond capabilities to emerging needs. Dedicated integrators were responsible for negotiating customer relationships and ensuring employee commitments.*
Modular processes and products	*The organizational structure did not leverage utilization of the component-based software architecture. The management group compensated by generating unique responses to emerging needs.*	*Ability to dynamically re-negotiate and adjust individual and group responsibilities and commitments leveraged utilization of the component-based software architecture. Dedicated integrators ensured alignment between emerging needs and organizational and individual priorities.*

Concerning the principle of processes that learn, at *Mature Inc.* five cross-functional teams sensed and responded to events related to management, product innovation, sales and marketing, partnering, and software development. Their charter was to determine when and how changes should be implemented within a dedicated domain. For example, the product steering group met on a regular basis and discussed how to proceed with product offerings. Also, to know earlier, *Mature*

Inc. aimed at analyzing data about current and potential customers, markets, and competitors. They also used technology extensively to collect and analyze data. The overall purpose was to maintain and develop the firm's competitiveness within the boundaries of the values and strategies that were explicitly shared between the five teams. In contrast, all sense-and-respond cycles at *Starter Inc.* were centralized to the management group. Although the group according to the CEO *"included all the necessary people"* important business decisions were initiated and taken by the group itself. In fact, the management group was highly sensitive to marketplace events and feedback; it responded quickly to customer and market needs; and the communication with employees was frequent. But, employee participation was limited and communication was informal. *"There is no a certain procedure for an agenda; on the contrary, meetings are ad hoc, simple and relaxed,"* said the CEO. Also, *Starter Inc.* ignored systematic analyses of data because of scarce resources. Actions were instead based on the intuition and ad-hoc decisions of the management group. The people running the company seemed to make all major decisions in response to their perception of customer requests and market dynamics.

Also, governance mechanisms differed between the two firms. At *Mature Inc.* governance was enacted through intensive networking, internally across functions and externally with customers and partners. The guiding values were explicated, communicated, and shared across the firm. *Starter Inc.* had, in contrast, less shared experience and history on which they could develop new approaches and responses. *Starter Inc.* had so far focused entirely on creating one core product and a market for it. They had just closed three major customer deals, and increasingly diverse and customer-centric development activities therefore required more efficient software development. The company had a simple functional structure to separate developers from salesmen, and management had assumed most of the responsibility for instituting direction. *"The management group makes all the decisions, the salesmen sell the product, and developers develop according to the instructions,"* summarized the CEO. However, the centralized approach was becoming inappropriate for coordinating responses to increasingly diverse needs and requests. Individual employees had knowledge directly relevant for responding to emerging events; but it was difficult to exploit and share this knowledge as informal discussion was the only available channel of communication. Although the management group recognized the need to move towards increased delegation of response ability, it was difficult for them to transcend the current set-up.

Differences in negotiating personal accountabilities were also visible. At *Mature Inc.*, team members were individually accountable for outcomes within their specific areas. The five teams operated as complementary antennas to the external world, thus strengthening the company's

ability to identify relevant signals within dedicated areas. Although negotiating commitments among employees was somewhat informal, responses, their specification, and related risks were explored and made explicit within each team. In contrast, *Starter Inc.*'s activities were supervised by the management group and lower-lever employees were not empowered to act on their own. Because outcomes of processes were not clearly defined, there were rather weak commitments between people. Action was often more reactive than proactive, because of insufficient capacity for sensing signals and inappropriate capabilities to dynamically reconfigure commitments beyond the management group. There was no common protocol of accountabilities, but the close-knit management group used frequent and ad-hoc interactions to support coordination and decision making. As a consequence, they had difficulties communicating beyond the group when and how employees should be involved in sense-and-respond activities. Also, the group's responses were not effectively communicated and shared across the firm.

Finally, although both companies had modular product architectures, there were differences in their ability to adapt processes to leverage component reuse. At *Mature Inc.*, they were able to dynamically integrate, build, and reconfigure new combinations of processes to deliver tailored responses to customer requests. At *Starter Inc.*, they did not have a modular process structure in place which made it more difficult to take advantage of the component-based product architecture.

V. DISCUSSION

Guided by two propositions and the sense-and-respond framework we have analyzed sense-and-respond behaviors and mechanisms within and across two small software firms. The purpose of this analysis was to offer knowledge regarding the applicability of the sense-and-respond framework to assess, design, and manage dynamic capabilities in small software firms. In the following, we discuss the findings from the analysis.

A. Proposition 1

We found that the sense-and-respond framework provided an integrated view of process-level and firm-level dynamic capabilities in both software firms. The framework allowed us to identify and analyze important dynamic capabilities related to input, process, and output aspects of the software development life-cycle. Related to the input to software development, we saw how core competencies in both firms were managed in attempts to match external demands and opportunities [10]. Related to the process itself, we saw how development practices with different levels of ease were adapted in response to emerging needs [34]. Finally, related to output, the analysis of *Mature*

Inc. showed how developer teams used modular architectures as more or less explicit coordination mechanism to generate quick responses to specific customer requests [47].

The analysis of episodes generally helped us understand how managers acquire and share resources, integrate them together, and recombine them to generate new sources of competitive advantage [8, 17, 21]. Both firms – more or less successfully – developed tailored responses by snapping together components from a modularized product architecture [12]. At *Starter Inc.* we saw how the management group shaped its strategy and specific responses by continuously pooling and integrating different management and engineering practices [71]. In *Mature Inc.* we identified a more systematic patching process [72, 73] in which the firm structured its modular product and services to match shifting customer demands supported by intensive customer interactions and regular market surveys.

Other dynamic capabilities focused on gaining or releasing resources [17], including alliances to bring new resources in from external sources [74, 75]. In this respect, we found that *Mature Inc.* systematically accessed outside knowledge through a number of autonomous and coordinated sense-and-respond cycles. *Starter Inc.* articulated the need for such capabilities, but the firm did not manage to communicate business values and assign personal accountabilities to effectively involve other stakeholders beyond the central management group.

Both firms adopted functional integration as an approach to new product development [76, 77, 78]. At *Mature Inc.*, the product steering group consisted of members from several functions and it constantly negotiated how to align products and services with emerging needs and trends. At *Starter Inc.* a similar functional integration was negotiated by the management group by bringing together different sources of expertise for product management in an ad-hoc fashion.

Another common feature identified across the two firms was networking during software development allowing projects to get meaningful, high-fidelity feedback on the performance of their products and to subsequently develop appropriate responses [35, 36, 37, 38]. Indeed, extensive knowledge sharing with the outside world characterized both firms. The continued development of a common experience base facilitated communication among sources inside and outside the firm [17] and it helped the firms know earlier about changes in the environment [13]. Networking was also supported by visualization and simulation of situation-specific knowledge [70], such as extensive and frequent use of prototyping, experimentation, and multiple alternatives. While *Mature Inc.* had established a team to maintain active communication with external parties, *Starter Inc.'s* approach was less systematic and explicit. This is consistent with the insight that such

capabilities often develop in context specific ways as expressions of how economic exchanges are socially embedded [22, 79, 80].

Finally, the sense-and-respond framework helped us understand how learning shaped dynamic capabilities within each firm [17, 81]. At *Mature Inc.*, the relationship management team was devoted to develop and monitor collaboration on both the process- and firm-level. Also, the software development team reconsidered and assessed previous development projects to exploit relevant experiences for current development projects. Similarly, within *Starter Inc.* the management group explicitly modeled relationships to their partners and competitors to improve the firm's capability to create new insights into market and technology opportunities.

B. Proposition 2

The two software firms sought growth based on initial venture capitalists' investments, they operated in similar contexts, they had similar goals, and they were of comparable size. It is therefore not surprising that we found similarities in dynamic capabilities across the two firms. Dynamic capabilities can generally vary from stable, incremental practices to experimental, innovative practices depending on market characteristics [17, 82]. In moderately dynamic markets, variation is addressed through evolution of existing processes. In contrast, in high-velocity markets, change is more disruptive based on creation and selection of new approaches. As both firms operated in high-velocity markets, they relied on being able to rapidly create new situation-specific responses and they were reluctant to commit to standardized processes. *"Of course we have process descriptions, but those are adjusted as necessary,"* summarized the CTO at *Mature Inc*.

There were, however, important differences in stages of development between the two firms. As a consequence, we found that the sense-and-respond approach also revealed important differences in dynamic capabilities between *Starter Inc.* and *Mature Inc.* We identified dynamic capabilities related to all four of Haeckel's systemic sense-and-respond principles [13] in both firms, but the two firms demonstrated quite different approaches to how the principles were practiced. These differences are summarized in Table D.

While software development and management practices were adapted as needed in both firms, we found quite different approaches to these adaptive behaviors across the two firms. At *Mature Inc.*, a combination of shared values and direct management interaction kept teams focused on their commitments and supported their ongoing prioritization of resources. This context of simple boundary and priority-setting practices allowed the employees to develop 'know-why' competencies and to constantly align roles and accountabilities [14, 51]. In contrast, because of the

centralized decision making and coordination at *Starter Inc.*, only the management group was up-to-date with how company values and priorities evolved based on their own attempts to respond to environmental dynamics. Structuring of processes and management of personal accountabilities was therefore an ongoing struggle. *"A little chaos is necessary,"* concluded the CEO at *Starter Inc.*, *"but deadlines, documentation and version management have to be performed properly."* While both firms in their high-velocity markets relied on sharing a business vision to bound new product configurations and support adherence to schedule [83], their approaches were quite different. With a decentralized approach based on systematic information sharing, *Mature Inc.* was able to communicate the evolvement of its governance mechanisms to more effectively respond to environmental dynamics. *Starter Inc.*'s centralized approach relied on values embedded into the practices of the management group. This approach reduced the firm's ability to respond making it difficult to exploit available resources outside the management group.

Although the two firms had quite similar resources, they had a different history assessing and innovating product development [34]. *Mature Inc.* had experienced steady growth during the last six years, and, in particular, they had been able to evaluate and reflect on their performance against past product development efforts. This experience had helped them develop a strong portfolio of dynamic capabilities that allowed them to effectively exploit resources within the firm and across the business network. In contrast, *Starter Inc.* had recently grown to become more complex, and processes and governance structures were still loose. The management group continued to operate as the core team of innovative entrepreneurs in charge of the firm's sense-and-respond practices. Even though the managers shared the core values that set the borders for decentralized responses, they failed to enhance the firm's response ability because they did not explicate and share information idiosyncratic to all members [84].

VI. IMPLICATIONS

The presented study is about management in small software firms. These firms are constrained by limited and tightly scheduled resources, predominantly fixed costs of service development, and often high dependence on one or a few large and powerful players within the industry. Small software firms are therefore extremely vulnerable to changes in technologies and markets. While the study has addressed these particular challenges, it has definite limitations. The study is exploratory in nature; it is based on a comparative study of two software firms; and, it is driven deductively by a particular view on organizational agility [12, 13, 14] without consideration of other possible frameworks [e.g. 10]. Moreover, the analysis focuses selectively on particular sense-

and-respond episodes. Despite these limitations there are important implications for both practice and research.

At *Starter Inc.* and *Mature Inc.*, the sense-and-respond approach helped identify and assess core dynamic capabilities. The analysis helped us appreciate barriers and enablers to appropriate sense-and-respond behavior and we learned that certain organizational designs and management practices are more feasible than others. For instance, by decentralizing into smaller and quick-responding teams coordinated by shared values and goals, small software companies can use their limited and tightly scheduled resources to sense individual customer needs earlier and respond quickly through mass-customization. Also, the ability to integrate services with relevant complementary offerings through partnerships within business networks reduces the dependencies on large and powerful players within the industry. Managers of small software firms are on that basis advised to adopt sense-and-respond approaches to assess and develop appropriate dynamic capabilities. In doing so, they are advised to focus on process-level as well as firm-level capabilities based on the principles of sense-and-respond organizations [13]: processes that learn; value-based governance; dynamic personal accountabilities; and modular processes and products.

The study has also implications for future research. Although our exploration offers promising results, the descriptive potential of the sense-and-respond approach in this particular context still needs to be further validated and its prescriptive implications for management needs to be further developed. Because specific dynamic capabilities can vary across industries, and because capabilities can be substitutable and exist across firms [17], one possible approach would be to develop a sense-and-respond framework dedicated to manage dynamic capabilities in small software firms. Such efforts would capture and exploit industry-specific dynamic capabilities in more detail; it would differentiate between particular key process areas (e.g. requirements management, project management, configuration management, and quality assurance); and it would help the software discipline expand and complement its current focus on agile development methods [40].

VII. CONCLUSION

Our exploratory case study suggests that a sense-and-respond framework is helpful in assessing, designing, and managing dynamic capabilities in small software firms. Our sense-and-respond analysis of the two software firms helped integrate important dynamic capabilities into a coherent view, it offered process-level as well as firm-level insights into relevant dynamic capabilities, and it covered a variety of dynamics capabilities over the software development life-cycle. Across the two firms, the framework revealed important variations in sense-and-respond practices reflecting

the different levels of maturity between the two firms. The findings from the exploratory study encourage additional research to further explore the descriptive and prescriptive value of the sense-and-respond approach in this particular industrial context.

REFERENCES

[1]K. Dulaney, "Predicts 2004: Mobile and Wireless," *Gartner Research*, vol. AV-21-5094, 2003, pp.

[2]D.C. Plummer and A.-M. Roussel, "Predicts 2005: Deploy New Technology, Application for Success," *Gartner Research*, vol. G00124735, 2004, pp.

[3]A.J. Campbell and D.T. Wilson, "Managed Networks: Creating Strategic Advantage," in Dawn Iacobucci, ed., *Networks in Marketing*, London: SAGE Publications, 1996, pp. 125-143.

[4]T.L. Amburgey, D. Kelly, and W.P. Barnett, "Resetting the Clock: The Dynamics of Organizational Change and Failure," *Administrative Science Quarterly*, vol. 38, 1993, pp. 51-73.

[5]E. Penrose, *The Theory of the Growth of the Firm*, Oxford, UK: Blackwell, 1959.

[6]J. Barney, "Firm Resources and Sustained Competitive Advantage," *Journal of Management*, vol. 17, no. 1, 1991, pp. 99-120.

[7]B. Wernefelt, "A Resource-Based View of the Firm," *SMJ*, vol. 5, 1984, pp. 171-180.

[8]D.J. Teece, G. Pisano, and A. Shuen, "Dynamic Capabilities and Strategic Management," *SMJ*, vol. 18, no. 7, 1997, pp. 509-533.

[9]V. Sambamurthy, A. Bharadwaj, and V. Grover, "Shaping Agility Through Digital Options: Reconceptualizing The Role of Information Technology in Contemporary Firms," *Mis Q.*, vol. 27, no. 2, June 2003, pp. 237-263.

[10]R. Dove, *Response Ability: The Language, Structure, and Culture of the Agile Enterprise*, New York: John Wiley & Sons, Inc., 2001.

[11]P.T. Kidd, *Agile Manufacturing: Forging New Frontiers*, Cornwall: Addison Wesley, 1995.

[12]S.H. Haeckel, *Adaptive Enterprise: Creating and Leading Sense-and-Respond Organizations*, Boston, Massachusetts: Harvard Business School Press, 1999.

[13]S.H. Haeckel, "Adaptive Enterprise Design: The Sense-and-Respond Model," *Planning Review*, vol. 23, no. 3, 1995, pp. 6-42.

[14]S.H. Haeckel, "Peripheral Vision: Sensing and Acting on Weak Signals Making Meaning out of Apparent Noise: The Need for a New Managerial Framework," *Long Range Planning*, vol. 37, 2004, pp. 181-189.

[15]G. Walsham, *Interpreting Information Systems in Organizations*, Chichester: Wiley & Sons, 1993.

[16]R.K. Yin, *Case Study Research: Design and Methods*, Second, Applied Social Research Methods Series, Diane S. Foster, Vol. 5, Thousand Oaks: Sage Publications, Inc., 1994.

[17]K.M. Eisenhardt and J.A. Martin, "Dynamic Capabilities: What Are They?" *SMJ*, vol. 21, 2000, pp. 1105-1121.

[18]S.L. Brown and K.M. Eisenhardt, "Product Development: Past Research, Present Findings and Future Directions," *Academy of Management Review*, vol. 20, no. 2, 1995, pp. 343-378.

[19]H. Volberda, *Building the Flexible Firm: How to Remain Competitive*, New York: Oxford University Press, 1998.

[20]D. Zahay, A. Griffin, and E. Fredericks, "Sources, Uses, and Forms of Data in the New Product Development Process," *Industrial Marketing Management*, vol. 33, no. 7, 2004, pp. 657-666.

[21]R.M. Grant, "Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration," *Organization Science*, vol. 7, no. 4, 1996, pp. 375-387.

[22]B. Kogut and U. Zander, "Knowledge of the Firm, Combinative Capabilities and the Replication of Technology," *Organization Science*, vol. 3, no. 3, 1992, pp. 383-397.

[23]F.J. Mata, W.L. Fuerst, and J.B. Barney, "Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis," *Mis Q.*, vol. 19, no. 4, 1995, pp. 487-506.

[24]A.M. Vainio, T. Tuunanen, and P. Abrahamsson, "Developing Software Products for Mobile Markets: Need for Rethinking Development Models and Practices," in *Proceedings of Hawai'i International Conference on System Sciences HICSS-38*, Hawaii, the Big Island, 2004.

[25]S. Nambisan, "Why Service Business Are Not Product Businesses," *MIT Sloan Management Review*, vol. 42, no. 4, 2001, pp. 72-81.

[26]M.E. McGrath, *Product Strategy for High-Technology Companies: Accelerating Your Business to Web Speed*, 2nd, New York: McGraw-Hill Companies, 2001.

[27]B. Curtis, M.I. Kellner, and J. Over, "Process Modeling," *CACM*, vol. 35 (9), 1992, pp. 75-90.

[28]M. Keil and E. Carmel, "Customer-developer links in software development," *Communications of the ACM*, vol. 38, no. 5, 1995, pp. 33-44.

[29]R.G. Cooper, "Stage-Gate Systems - a New Tool for Managing New Products," *Business Horizons*, vol. 33, no. 3, 1990, pp. 44-54.

[30]A. De Maio, R. Verganti, and M. Corso, "A Multi-Project Management Framework for New Product Development," *European Journal of Operational Research*, vol. 78, no. 2, 1994, pp. 178-191.

[31]S.J. Hart and M.J. Baker, "The Multiple Convergent Processing Model of New Product Development," *International Marketing Review*, vol. 11, no. 1, 1994, pp. 77-92.

[32]K.B. Clark and S.C. Wheelwright, *Managing New Product and Process Development: Text and Cases*, New York: The Free Press, 1993.

[33]R. Cooper, "Winning with New Products Doing it Right," *IVEY Business Journal*, vol. July-August 2000, 2000, pp. 54-60.

[34]S.J. Marsh and G.N. Stock, "Building Dynamic Capabilities in New Product Development through Intertemporal Integration," *Journal of Product Innovation Management*, vol. 20, 2003, pp. 136-148.

[35]A. Cockburn, *Agile Software Development*, Boston: Addison-Wesley, 2002.

[36]G. Fitzgerald, "Formalised Systems Development Methodologies: A Critical Perspective," *Information Systems Journal*, vol. 6, 1996, pp. 3-23.

[37]J. Highsmith and A. Cockburn, "Agile Software Development: The Business of Innovation," *Computer*, vol. 34, no. 9, 2001, pp. 120-122.

[38]B. Ramesh, J. Pries-Heje, and R. Baskerville, "Internet Software Engineering: A Different Class of Processes," in Y. Wang and A. Bryant, ed., *Annals of Software Engineering: Process-based Software Engineering*, Vol. 14, New York: Kluwer Academic Publishers, 2002, pp. 169-195.

[39]R. Baskerville, L. Levine, J. Pries-Heje, B. Ramesh, and S.A. Slaughter, "Balancing Quality and Agility in Internet Speed Software Development," in *Proceedings of 23rd International Conference on Information Systems*, Barcelona, Spain, 2002.

[40]P. Abrahamsson, J. Warsta, M.T. Siponen, and J. Ronkainen, "New Directions on Agile Methods: A Comparative Analysis," in *Proceedings of in the Proceedings of the 25th International Conference on Software Engineering*, Portland, Oregon, 2003, pp. 244-254.

[41]http://www.agilemanifesto.org.

[42]D. Truex, R. Baskerville, and J. Travis, "A Methodical Systems Development: The Deferred Meaning of Systems Development Methods," *Accounting, Management and Information Technologies*, vol. 10, no. 1, 2000, pp. 53-79.

[43]W.S. Newman, A. Podgurski, R.D. Quinn, F.L. Merat, M.S. Branicky, N.A. Barendt, G.C. Causey, E.L. Haaser, Y. Kim, J. Swaminathan*et al.*, "Design Lessons for Building Agile Manufacturing Systems," *IEEE Transactions on Robotics and Automation*, vol. 16, 2000, pp. 228-238.

[44]M. Sparling, "Lessons Learned Through Six Years of Component-Based Development," *Communication of the ACM*, vol. 43, 2000, pp. 47-53.

[45]R.G. Cooper, S.J. Edgett, and E.J. Kleinschmidt, "New Product Portfolio Management: Practices and Performance," *Journal of Product Innovation Management*, vol. 16, no. 4, 1999, pp. 333-351.

[46]S. Sawyer, "A Market-Based Perspective on Information Systems Development," *Communication of the ACM*, vol. 44, 2001, pp. 97-102.

[47]R. Baskerville and J. Pries-Heje, "Short Cycle Time Systems Development," *Information Systems Journal*, vol. 14, 2004, pp. 237-264.

[48]W.A. Sheramata, "Finding and Solving Problems in Software New Product Development," *Journal of Product Innovation Management*, vol. 19, 2002, pp. 144-158.

[49]H. Sharifi and Z. Zhang, "Agile Manufacturing in Practice: Application of a Methodology," *International Journal of Operations & Production Management*, vol. 21, no. 5/6, 2001, pp. 772-794.

[50]P.T. Kidd, *Rapid Prototyping for Competitive Advantage: Technologie, Applications and Implementaiton for Market Success*, Macclesfield: Chashire Henbury, 1997.

[51]S.H. Haeckel, "Leading on Demand Businesses - Executives as Architects," *IBM Systems Journal*, vol. 42, no. 3, 2003, pp. 405-413.

[52]M. Jackson and C. Johansson, "An Agility Analysis from a Production System Perspective," *Integrated Manufacturing Systems*, vol. 14, no. 6, 2003, pp. 482-488.

[53]A. Salazar and R. Hackney, "The Strategic Impact of Internet Technology in Biotechnology and Pharmaceutical Firms: Insights from a Knowledge Management Perspective," *Information Technology & Management*, vol. 4, 2003, pp. 289-301.

[54]M. Zain, N.M. Kassim, and E. Mokhtar, "Use of Information Technology and Information Systems for Organizational Agility in Malaysian Firms," *Singapore Management Review*, vol. 25, no. 1, 2003, pp. 69-83.

[55]S.H. Huang, M. Uppal, and J. Shi, "A Product Driven Approach to Manufacturing Supply Chain Selection," *Supply Chain management*, vol. 7, no. 4, 2002, pp. 189-199.

[56]L.E. Greiner, "Evolution and Revolution as Organizations Grow," *Harvard Business Review*, 1998, pp.

[57]Z. Zhang and H. Sharifi, "A Methodology for Achieving Agility in Manufacturing Organizations," *International Journal of Operations & Production Management*, vol. 20, no. 4, 2000, pp. 496.

[58]J. Mason, *Qualitative Research*, Second Edition, CA: Sage Publication: Thousand Oaks, 2004.

[59]H.K. Klein and M.D. Myers, "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems," *Mis Q.*, vol. 23, no. 1, 1999, pp. 67-93.

[60]W.J. Orlikowski and J.J. Baroudi, "Studying Information Technology in Organizations: Research Approaches and Assumptions," *Information Systems Research*, vol. 2, no. 1, 1991, pp. 1-28.

[61]S.R. Barley, "Technology as an Occasion for Structuring: Evidence from Observations of CT Scanners and the Social Order of Radiology Departments," *Administrative Science Quarterly*, vol. 31, 1986, pp. 78-108.

[62]L. Heaton, "Talking Heads vs. Virtual Workspaces: A Comparison of Design across Cultures," *Journal of Information Technology*, vol. 13, 1998, pp. 259-272.

[63]W.J. Orlikowski, "CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development," *MIS Quarterly*, vol. 17, no. 3, 1993, pp. 309-340.

[64]M.B. Miles and A.M. Huberman, *Qualitative Data Analysis: An Expanded Sourcebook*, 2nd, Newbury Park, CA: Sage Publications, 1994.

[65]H.J. Rubin and I.S. Rubin, *Qualitative Interviewing: The Art of Hearing Data*, Thousand Oaks, CA: Sage, 1995.

[66]R.K. Merton, M. Fiske, and P.L. Kendall, *The Focused Interview: A Manual of Problems and Procedures*, New York: Free Press, 1990.

[67]S. Nambisan, "Complementary Product Integration by High-Technology Ventures: The Role of Initial Technology Strategy," *Management Science*, vol. 48, no. 3, 2002, pp. 382-398.

[68]D. Cusumano and Yoffie, *Competing on Internet Time*, New York: The Free Press, 1998.

[69]S.A. Alvarez and G.D. Meyer, "Technology Based Strategic Alliances: Are They Good for Entrepreneurial Firms?" *Frontiers of Entrepreneurship Research*, Babson Park, MA: Babson College, 1999.

[70]S. Nambisan, "Designing Virtual Customer Environments for New Product Development: Toward a Theory," *Academy of Management Review*, vol. 27, no. 3, 2002, pp. 392-413.

[71]K.M. Eisenhardt, "Making Fast Strategic Decisions in High-Velocity Environments," *Academy of Management Journal*, vol. 32, no. 3, 1989, pp. 543-576.

[72]J. Magretta, "The Power of Virtual Integration: An Interview with Dell Computer's Michael Dell," *Harvard Business Review*, vol. 76, no. 2, 1998, pp. 72-84.

[73]K.M. Eisenhardt and S.L. Brown, "Patching: Restiching Business Portfolios in Dynamic Markets," *Harvard Business Review*, vol. 77, no. 3, 1999, pp. 72-82.

[74]R. Gulati, "Alliances and Networks," *SMJ*, vol. 19, 1998, pp. 293-317.

[75]P.J. Lane and M. Lubatkin, "Relative Absorptive Capacity and Interorganizational Learning," *SMJ*, vol. 19, no. 5, 1998, pp. 461-478.

[76]G. Barczak, "New Product Strategy, Structure, Process, and Performance in the Telecommunications Industr," *Journal of Product Innovation Management*, vol. 12, no. 3, 1995, pp. 224.

[77]A. Gupta, "The R&D-Marketing Interface in High-Technology Firms," *Journal of Product Innovation Management*, vol. 2, no. 1, 1985, pp. 12.

[78]W.E. Souder, "Managing Relations Between R&D and Marketing in New Product Development," *Journal of Product Innovation Management*, vol. 5, 1988, pp. 6-19.

[79]W.M. Cohen and D.A. Levinthal, "Absorptive Capacity: A New Perspective on Leaning and Innovation," *Administrative Science Quarterly*, vol. 35, no. 1, 1990, pp. 128-152.

[80]P.R. Beije and J. Groenewegen, "A Network Analysis of Markets," *Journal of Economic Issues*, vol. 26, no. 1, 1992, pp. 87-104.

[81]G. Hamel, "Competition for Competence and Interpartner Learning within International Strategic Alliances," *SMJ*, vol. 12, 1991, pp. 83-103.

[82]K. Möller and S. Svahn, "Managing Strategic Nets: A Capability Perspective," *Marketing Theory*, vol. 3, no. 2, 2003, pp. 209-234.

[83]S.L. Brown and K.M. Eisenhardt, "The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations," *Administrative Science Quarterly*, vol. 42, no. 1, 1997, pp. 1-34.

[84]L. Argote, B. McEvily, and R. Reagans, "Managing Knowledge in Organizations: An Integrative Framework and Review of Emerging Themes," *Management Science*, vol. 49, no. 4, 2003, pp. 571-582.

APPENDIX I

Summary of Study Protocol following Yin [16]

A. Introduction to the case study and purpose of protocol
A1 Case study questions, hypotheses and propositions
Proposition 1: The sense-and-respond framework provides an integrated view of process-level and firm-level dynamic capabilities in small software firms
Proposition 2: The sense-and-respond framework reveals differences in dynamic capabilities between immature and mature small software firms
A2 Theoretical framework for the case study
Sense-and-respond framework by Haeckel [12, 13, 14]
A3 Role of protocol in guiding the case study investigator
Agenda for the line of inquiry and basis for data analysis
B Data collection procedures
B1 Names of sites to be visited, including contact persons
Starter Inc. – the CEO, the CTO, and two project managers
Mature Inc. – the head of business development, the head of software development, and two project managers
B2 Data collection plan
Acquiring written material such as brochures, annual reports, internal documents, and trade journal articles
Going through archives such as marketing presentations, organizational records, project documentation, and customer records
Theme interviews conducted during spring 2003
- The amount of time per interview: 2 hours
- The amount of interviews: 5 initial interviews and 5 follow-up interviews in each firm
Observations through site visits
B3 Expected preparation prior to site visits
Identify specific documentation, such as www-site, brochures, news, to be reviewed
C Outline of case study report
C1 A within-case analysis of sense-and-respond episodes on process-level followed by a firm-level analysis of sense-and-respond enablers and barriers in each firms
C2 A cross-case analysis of sensing and respond principles on firm-level
D Case study questions
D1 How can the sense-and-respond framework be used to assess, design, and manage dynamic capabilities in small software firms?
a) Why and how certain environmental signals are sensed and interpreted? How responses are designed and decided upon?
Identify sense-and-respond episodes throughout the life-cycle of a software product. Point out the sense-and-respond cycle activities in each episode.
b) How internal practices, such as management, business development, and marketing practices, support sensing and responding to signals in the environment?
Identify the enablers and barriers for sense-and-respond behaviour.
c) How sensing and responding to events in environments are implemented in project management?
Identify the enablers and barriers for sense-and-respond behaviour.
d) How sensing and responding to events in environment are implemented in software development?
Identify the enablers and barriers for sense-and-respond behaviour.

APPENDIX II

Interviewees	Focus	Themes
Mature Inc. Head of business development Starter Inc. The CEO	Why and how certain environmental signals are sensed and interpreted and how responses are designed and decided upon	Competitive environment Customer segmentation Motivation for developing new products Development strategy for mobile software products (first-to-market; fast follower; delay entrant) Implementation of product concept Phases of product development Decision-making during software product development The participants involved in decision-making during development Internal & external Their contribution and roles Structure of software product development
Mature Inc. Head of business development Starter Inc. The CEO	Management, business development, and marketing practices – How internal practices support sensing and responding to signals in their environment	Firm characteristics and its business environment Turnover; personnel; office locations; organization; product concept; a business model; customers and references Business partners and their selection Main trends of their business area Firm's business concept Focus areas of business
Mature Inc. Project manager 1 Project manager 2 Starter Inc. Project manager 1 Project manager 2	The project management activities – How sensing and responding to events in environments are implemented in project management	Software development during the product life cycle Functional integration of software development Project communication Requirements elicitation Phases of software engineering Participants involved in each phase Organizational arrangements for software engineering Quality assurance
Mature Inc. Head of software development Starter Inc. The CTO	Software development practices – How sensing and responding to events in environment are implemented in software development	Software engineering Software development approach Functional integration in software development Requirements elicitation Phases of software engineering Participants involved in each phase Organizational arrangements for software engineering Quality assurance

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