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Antecedents of project learning and time-to-market during new mobile service development

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Abstract *Mobile service innovations are crucial for the long-term success of companies operating in turbulent and uncertain environments. These innovations need to be introduced at a rapid pace while at the same time companies have to absorb market information during the new mobile service development. Hence, the purpose of this paper is to construct a conceptual framework on the critical antecedents of project learning and time-to-market during new mobile service development. An extensive case study research involving four innovation projects was performed in a leading Dutch telecommunications company. With respect to project learning, our research findings indicate the crucial influence of a flexible decision architecture, project team memory, a high information awareness and a good fit between information requirements and capabilities. Both innovative and coordinative communication are required throughout the service innovation process. With regard to time-to-market, our research results point to the essential impact of project complexity, top management support, information power of suppliers and technological synergy. Finally, a medium level of project learning is the ideal condition for a fast time-to-market during mobile service innovation.*

Introduction

As the mobile telecommunications market is shifting toward saturation, telecommunications companies in Europe need the introduction of UMTS to supply additional capacity and offer new revenue-generating services (Durlacher, 2001). Increasingly, mobile operators will derive revenues from mobile service innovations competing to develop a value-added user experience (Durlacher, 2000). Mobile service innovations are defined as any new services that are delivered with the support of wireless devices. Within the telecommunications market, the mobile services market is one of the most dynamic and fastest growing segments (IDC Research, 2000). So far, mobile commerce applications have not been very successful, as many consumers did not adopt these services in combination with the GSM[1] standard. However, telecommunications companies believe that especially the UMTS[2] introduction will lead to a widespread adoption of mobile services in combination with mobile commerce applications.

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The mobile telecommunications industry comprises a highly competitive, dynamic and uncertain environment (Lal *et al.*, 2001), hence high velocity of innovation introductions in the market is a key success factor for offering new value-added services in the mobile industry[3]. Extant literature has shown that a fast time-to-market of an innovation creates a sustainable competitive advantage (Karagozoglu and Brown, 1993; Sherman *et al.*, 2000; Lynn *et al.*, 1999; Meyer and Purser, 1993; Kessler and Chakrabarti, 1996; 1999; Griffin, 1997; Bayus, 1997). Mobile businesses can achieve a pioneering advantage by the fast introduction of new services. Research has revealed that pioneers benefit from higher brand recognition and a likely increase in customer loyalty due to customers' reluctance to change to competitors' services because of high information and switching costs. Moreover, innovation speed increases resource efficiency as long development time takes away resources from other prospective projects (Eisenhardt and Tabrizi, 1995) and reduces the risk of launching an obsolete service in the market. However, some research has questioned whether it is always appropriate to aim for a quicker time-to-market (Bayus *et al.*, 1997; Gupta *et al.*, 1992; Millson *et al.*, 1992). For example, Bayus (1997) found that project teams have to balance high quality and low costs with fast time-to-market of an innovation as only two of the latter three goals can be emphasized for a specific innovation project. Nevertheless, time-to-market remains an important performance measure where additional research is required as to the interaction with other organizational determinants, such as learning.

The velocity of an innovation project depends on project learning, i.e. the effective processing of market and technological information into successful mobile services by project team members. The latter clearly implies that project teams build knowledge, hence learn throughout the innovation process. Effective information processing provides the project team with a more complete set of alternatives, which reduces the probability that unanticipated problems may impede the development of a new service. Information processing activities consist of the acquisition, the dissemination and the interpretation of information within the project team (Huber, 1991; Moorman, 1995; Sinkula, 1994; Slater and Narver, 1995). Therefore, project innovation teams are seen as information systems that explore and exploit organizational knowledge. However, especially in uncertain and dynamic markets, information overload may increase the time-to-market of an innovation due to the limitation of project team members' cognitive capacities (Zirger and Hartley, 1994)[3].

Despite the widely recognized importance of service innovation, hitherto little research attention has been granted to the critical factors of speed and knowledge during mobile service innovations. We believe that speed and knowledge are the major business components to achieve sustainable competitive advantage of new mobile services. Therefore, the purpose of this paper is to construct a conceptual framework on the critical antecedents of project learning and time-to-market during new mobile service development.

Considering the exploratory nature of our research question, we felt it was necessary to design and conduct a case study research in order to develop the relevant constructs[4] and develop hypotheses between these constructs. Following a literature review, an exploratory case study approach has been used within a leading Dutch telecom company. Desk research and in-depth interviews with senior managers and project leaders of four new mobile service projects served as a platform for theory development.

This article is structured as follows. We start by providing a description of the current situation for mobile operating companies using the concept of richness and reach (Evans and Wurster, 1997). The second section deals with the case study research design that was developed within a Dutch telecommunication company. Following the case study research findings, a propositional framework is formulated regarding the critical antecedents of speed and knowledge and their relationship with time-to-market and learning. Finally, we discuss the managerial and research implications of this study.

The new information economy: opportunities for mobile services

The diffusion of mobile commerce services, where consumers conduct commercial transactions via their wireless device, has been very poor so far due to high cost, slow transmission rates, high power consumption of devices and inadequate mobile interfaces (Barnes, 2002). Current mobile networks are mainly based on second-generation (2G) technology, e.g. GSM and PCS. Although the adoption of mobile commerce applications has not been successful yet, mobile phone penetration has been growing tremendously. At the end of 2001, there were one billion mobile phone users. Moreover, over 90 percent of countries had built a mobile phone network, almost every sixth of the worlds' inhabitants possessed a mobile phone and approximately 100 countries in the world had more mobile than fixed telephone subscribers (International Telecommunication Union, 2002). Barwise (2001) estimates that by 2010, in most developed countries 80-95 percent of consumers are expected to have at least one wireless device. Furthermore, mobile phone operators are investing massively in third generation (3G) wireless technologies that possess resilient data capabilities, e.g. UMTS (*Network World*, 2001). These 3G networks are expected to overcome especially the low data transmission rates.

Considering the richness and reach benefits, we define mobile business as the necessary application infrastructure in order to preserve business relationships and sell information, services, and commodities via mobile devices (Kalakota and Robinson, 2002). Before the Internet was used as an additional information channel, a very strict trade-off existed between richness and reach (Evans and Wurster, 1997; 1999). In these days, information mainly followed the linear flow of the physical value chain. Thus, it was almost impossible for a company to deliver personalized information to many customers. Either the company could provide many customers with the same information or could supply a limited number of people with personalized information. The latter implies a trade-off between richness and reach (Evans

and Wurster, 1997; 1999). Richness means the profundity of information that a business can offer to the customer, as well as the information profundity that it gathers about the customer. Reach is about access and connection, i.e. the number of customers a company has access to and connects with each other.

The Internet world has made this trade-off obsolete because as soon as all players within the value chain are connected electronically, information can flow in all directions. Moreover, companies are now able to have rich communication with many people at the same time, thus leveraging the informational value. However, when we compare the electronic world to the mobile world, mobile businesses might contain even more advantages.

In terms of richness, mobile businesses can gain more detailed information about the customer, as the mobile phone is a very personal device that is often not shared by different customers (O'Shea and Crowe, 2001; Kehoe, 2000; Barnett *et al.*, 2000). Thus, mobile behavior can be clearly linked to one person. If the customer has a postpaid contract, the mobile operator normally has access to detailed personal information that is necessary to get a phone subscription. Moreover, the users' locations are known when they consume specific services (O'Shea and Crowe, 2001; Kehoe, 2000; Barnett *et al.*, 2000). This additional information provides the opportunity to personalize existing and new services. Therefore, the company can obtain specific customer information by tracking customer behavior, which offers unique opportunities to develop new services.

In terms of reach, mobile services comprise time and space advantages in comparison to Internet services. Mobile services contain a time advantage because companies can deliver service offerings more frequently to the customer, as mobile phones are constantly switched on (O'Shea and Crowe, 2001; Barnett *et al.*, 2000). Furthermore, they include a space advantage as in mobile service delivery, the customer is reachable at all places, e.g. while sitting in a train or car or while waiting in a café. When using the Internet, users are bound to their computers to access specific service offerings.

Case study research design

We have developed a case study design at a leading Dutch telecommunications company. The company has a reputation for telecom innovations, and is considered to be a technological pioneer in that industry. A case study can be defined as:

> . . . an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (Yin, 1994, p. 13).

An inductive manner is being used, as we move from observation to the development of hypotheses (Judd *et al.*, 1991). Stated otherwise, the major function of our case study research efforts is "discovery" in which we focus on the heuristic view in science:

> The heuristic view in science emphasizes theory and interconnected conceptual schemata that are fruitful for further research. A heuristic emphasis is a discovery emphasis (Kerlinger, 1986, p. 8).

Thus, a case study research and a literature review were used as a platform for theory development. Reflective reasoning (Kerlinger, 1986) entered the research process during the literature analysis and has led to the design of a research set up to falsify the constructed research hypotheses. The case study data are being used for theory development following the process proposed by Eisenhardt (1989, p. 533) and Lievens *et al.* (1999a, p. 25, as described below).

Step 1
Formulation of research question containing preliminary constructs: project team learning, organization and communication antecedents, innovation project characteristics and time-to-market.

Step 2
Theoretically useful cases are being selected; four different projects/telecom service innovations are selected on the basis of two dimensions.

As already mentioned, the immediacy of mobile markets makes knowledge and speed two crucial factors for innovation performance. Therefore, the first dimension concerns the outcome of the service innovation, i.e. fast versus slow time-to-market. In selecting the projects, time-to-market was based on a broad base of innovation speed measures (Kessler and Chakrabarti, 1996). The description of the dimension included a time-related definition: "the time between the conception of an innovation and its introduction into the commercial market" (Gee cited in Kessler and Chakrabarti, 1996, p. 1151) and a goal-oriented definition: "the degree to which a product stayed on schedule, and the degree to which the work was done relative to how fast it could have been done" (Cooper and Kleinschmidt cited in Kessler and Chakrabarti, 1996, p. 1151). The second dimension relates to the level of information processing, i.e. a high level vs a low level of information processing. Recent research within e-businesses points to the crucial importance of handling the necessary information flows efficiently and effectively to be able to challenge knowledge and speed (Tapscott *et al.*, 1998).

A general innovation manager was chosen as the focal contact and was verbally informed about the project selection criteria. The term "project" was subsequently used to indicate the task or process of transforming a service idea into a new service introduced in the market. In order to maximize research validity, we have asked the contact manager to select projects that fulfilled the two following criteria:

(1) These four projects had been completed recently: market launch happened a maximum of six months ago.

(2) The projects are internal projects (or at least partly internal, i.e. not fully outsourced): personnel from different departments within the company were involved in the development of the project.

Finally, following these requirements, four mobile service innovation projects were selected based on the aforementioned dimensions (speed, level of information processing). In-depth interviews took place with involved project members (see Figure 1).

An embedded case study design is being used (Yin, 1994), because multiple units of analysis are defined (project level, type of innovations, decision makers). The first project (low level of information processing and slow time-to-market) dealt with developing a key service for a mobile telecommunication company: the delivery of voice and fax mail services. The second project (low level of information processing and fast time-to-market) was developed to ensure that content provided via SMS to the customer is up-to-date and adaptable to customer requirements. The third project (high level of information processing and slow time-to-market) aimed at designing a virtual private network where members can call each other on one personal short number at their office phone or their personal phone. The fourth project (high level of information processing and fast time-to-market) consisted of the development of information and entertainment services provided via the mobile phone. An extensive description of the four different projects can be found in Table I.

Step 3

The data collection methods of our case study research include both desk research and field research. First, desk research is based on internal company documents to obtain a good understanding of the marketing and the technological strategy of the company. Second, field research has been performed through in-depth interviews with key informants for each project (e.g. project leader, product manager, marketing manager, project team members). The selection dimensions have not been communicated to the interviewed project members, thereby avoiding bias.

An average of five in-depth interviews were conducted per project. The interview guide was built on the basis of the conceptual frameworks developed by Kessler and Chakrabarti (1996), Karagozoglu and Brown (1993), Sinkula

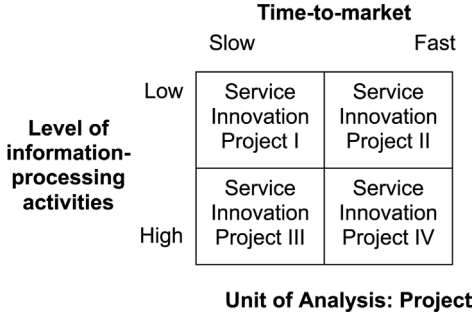

Figure 1.
Mobile service innovation projects: multiple units of analysis

Table I.
Description of the various service innovation projects

Level of information processing	Time-to-market: Slow	Time-to-market: Fast
Low	Project I	Project II
Short description	Project I consists of developing voice and fax mail services. It encompasses postpaid residential voice mail, prepaid voice mail and postpaid business voice mail	This service is a spin-off of project IV and is developed to offer new content via SMS. It is offered first for postpaid customers, while very soon this is also going to happen for prepaid users. Customers are able to get the latest information on subjects like traffic, weather, stock market, etc.
Strategic objective	The service had to be simple and user-friendly in order to develop usage by the customer, to ensure loyalty and develop a good image of the organization outside as well as inside. The objective for the business voice mail service was to target business users	The objective was to keep the content, which is send to mobiles, up-to-date and adjustable to the preferences of the consumer
Service delivery	The service was dedicated to postpaid packages and offered in a limited version to prepaid users. For the business package fax mail services were included to support a complete set of mailbox features	The new content can be found on the Internet and via sending an SMS

(continued)

	Time-to-market	
Level of information processing	Slow	Fast
High	Project III	Project IV
Short description	This service was about a virtual private network (VPN), which was a value added service for the organization's internal network. Members of a mobile VPN can call each other on one personal short number at their office phone or their personal phone	Project IV consists of developing a platform for offering information and entertainment services. Information services are about providing content, like traffic information and financials, to mobile users, when it is requested. Entertainment services provide the customer with jokes and horoscopes. The content is delivered as an SMS or via an IVR
Strategic objective	The objective was to increase the market share in the business market, capture business traffic from corporate networks, increasing customer loyalty, and obtain a competitive advantage over the competition	The objective was to create a "me-too' product, which did not need to be highly innovative. It had to be put fast onto the market, since the organization had to be present in this market field of value added services
Service delivery	The service is provided on request, as the virtual private network will be customised for the requesting company	The service is offered via SMS where the customer can request specific information or via the Internet where a customer can subscribe for frequently sent information

Table I.

(1994), Garvin (1993), Huber (1991) and Edmondson (1999). The questionnaire consisted of open-ended questions as this research is exploratory in nature. The interviews lasted between one and a half and two hours. The check-list contained open-ended questions that involved the following subjects:

- the actual innovation process and related information processing activities (acquisition, dissemination and sharing);
- project team diversity and existing knowledge (i.e. memory) as well as the nature of communication (i.e. innovative versus coordinative communication and inside project team versus outside project team communication); and
- the impact of project complexity, technological and marketing synergy as well as network effects on time-to-market.

Step 4

The transcripts of the interviews were used to perform a thematic content analysis. The preliminary conceptual model guiding our case study analysis is represented in Figure 1. The case study research process comprises an inductive process (Kerlinger, 1986) as we move from observation to the development of hypotheses. Thus, the case study data were screened for content themes relating to project learning and time-to-market.

Step 5

A model has been constructed through an iterative process involving first, a comparison with the relevant literature and second, a confrontation during a feedback workshop with the interviewed telecom personnel. During the course of the case study research, several feedback sessions were organized with the marketing manager of the participating telecom company. This person provided us with the necessary context variables we needed to acquire a more fine-grained insight in the processes and some of the findings. Moreover, the feedback sessions enabled us to steer and change our data collection procedures if necessary in order to enable the assessment of the plausibility of the data interpretation as well as the search for new cues. A final feedback session was organized within the telecom company inviting all participants of the case study research. Furthermore, one author of this paper spent an entire month at the company. This approach offered excellent access to key informants and company documents as well as continuous feedback for hypothesis formulation and validation of the results across the four case study projects.

Case study research findings

Antecedents of project learning

In the first stage of our case study research analysis, we identified the conditions preceding the building of a knowledge base. The following antecedents emerged from our analysis: decision architecture, information

awareness, project team memory, the fit between information capabilities and information requirements and the nature of communication.

Decision architecture. The studied innovation projects indicated that the decision architecture of the organization strongly influences project learning during the innovation process. Although the company had a very flexible organizational structure that supported fast and information rich projects, the organizational culture was characterized by a very hierarchical decision authority. For instance, in the virtual private network project (III) top management decided about the hardware basis for developing the service. The bought hardware was too complicated to design the new service and did not correspond to project team members' preferences. Without the regular approval of top management, the project members could not proceed with the development and launch of the virtual private network (III). The pressure on project teams caused by this system led to less effective project learning. Moreover, during the information and entertainment services project (IV) the technical department had to choose a supplier. Due to high pressures of the stage gate development process, the project team lacked sufficient time to select an appropriate supplier carefully. Two weeks after the decision for a certain supplier was taken, a more suitable candidate became available. This company could have contributed much better to efficient information processing activities. Moreover, learning was inhibited when the top manager was absent and could not take decisions that were necessary for the progress of a project. During the voice and fax mail services project (I), information processes were interrupted only because the manager who possessed decision authority was not reachable. Whenever the project teams had to wait for top management to take a decision, the whole project was stuck and learning was non-existent during these periods.

Decision-making is a key element of the information and interpretation processes in a company (Daft and Weick, 1984; Mendelson and Pillai, 1999; Simon, 1979). Flexible decision architecture is constituted by the co-location of decision rights, where the most knowledgeable people are responsible for taking decisions. Organizations in the traditional world mainly employed hierarchical structures and top-down processes (Mendelson, 2000; Johnson and Frohman, 1989). According to contingency theory, bureaucratic structures with top-down decision authority improve performance in stable environments whereas organic structures with decentralized decision-making authority enhance performance in turbulent environments (Lawrence and Lorsch, 1967; Moorman and Miner, 1997). Moreover, information quality vanishes when it has to go through many hierarchical layers. Considering the turbulent nature of the telecommunications industry and our case study findings, a flexible and decentralized decision architecture supports a fast and information rich service innovation process in the telecommunications industry (Mendelson and Pillai, 1999; MacCormack *et al.*, 2001). Thus, we suggest that decision-making authority should be co-located where the specific knowledge is available. Hence, we postulate the following proposition:

H1. The level of project learning is positively related to a high level of co-location of decision rights.

Project team memory. The four innovation projects designated that project team memory contributes to project learning. The interviewees described project team memory as the past knowledge from previous projects that could be used and applied to the respective service innovation project. The voice and fax mail services project (I) and the entertainment and information services project (IV) were initiated when the company was just founded. Formalized procedures and processes were not developed at that time, resulting in uncertainty about how to approach the design of the new services. Although both projects were set up to construct a relatively simple "me-too" service, the team members were rather inexperienced. Especially in the voice and fax mail services project (I), the involved marketing department did not have enough market information and hence had difficulties in fitting the service to the Dutch market. Contrary, the new content on SMS project (II), which was a follow-up of the information and entertainment services project (IV), could easily use the established procedures and processes and the already acquired knowledge. For instance, some team members were already familiar with the service platform and the targeted market.

Although the virtual private network project (III) was also started when formal rules were already established, this project suffered due to another major problem: the turnover of team members during the project life cycle. The project team manager changed three times during the development. In general, the interviewees reported a high turnover of middle management within the telecommunications industry. Consequently, time and knowledge were lost. Time was lost as the new project leader had to become acquainted with the existing project issues inhibiting efficient and smooth information processing. Additionally, knowledge was lost due to the extraction of information by the former project leader during the project life cycle. Therefore, the lock-in of knowledge is very important and showed to be one of the major priorities within telecommunication companies. Locking in the existing knowledge avoids the extraction of knowledge every time a project leader/member leaves and facilitates the access to appropriate information for new employees (Nevis *et al.*, 1995). Consequently, project team memory is a determining driver of project learning. It can be defined as the collective knowledge embedded within the service innovation project team. It includes shared ideas, information databases, formalized procedures and routines and the formal cultural codes of acting within the company (Sinkula *et al.*, 1997). This collective, already existing knowledge influences all information processes, i.e. the creation, the dissemination and the sharing of new knowledge. Thus, the already acquired knowledge is an important capability that the project team can build on (Kogut and Zander, 1992). In the turbulent mobile markets a company has to create absorptive capacity (Cohen and Levinthal, 1990) institutionalizing the right mechanisms to process new information. Absorptive capacity supports the recognition, processing and assimilation of new valuable information.

Therefore, project teams need to build up an experience memory in order to cope with the generation of new information. Experience smoothes the progress of knowing how to learn, how to incorporate new information, to spread and use it (MacCormack *et al.*, 2001). Consequently, we hypothesize the following proposition:

H2. The level of project learning will be positively related to the memory of service innovation project teams.

Information awareness. Information awareness, i.e. new information spread by different communication channels, is an essential mechanism to stimulate project learning. Within the studied projects, new valuable information about the market was mainly acquired via the Internet, brainstorm sessions and focus groups. Project team members were stimulated to share new information with other team members during project team meetings, by means of spreading minutes via e-mails and by sending electronic briefings via the Intranet.

Moreover, team members could disseminate and exchange information by using special project drives operating via the network system of the company. However, storing information electronically was not at all popular during most of the projects. Only in the entertainment and information services project, the drive was used to amass project related information, planning processes, and contracts due to a heavy promotion by the project manager. As a result, information was spread much more frequently and project team members performed a high level of information processing activities. Moreover, project team members felt that they had up-to-date information, which was a necessary requirement to develop this service. Especially in dynamic industries such as the telecommunications industry, firms have to generate new information about the latest technology trends, about actions of competitors and about changing consumer tastes and lifestyles in order to be able to develop services that suit the market. We define information awareness as the:

> . . . promotion of widespread awareness of new information from the organization's external environment, including information about markets, new technologies, and changes in customer tastes (Mendelson, 2000, p. 515).

Project teams need to acquire new external information continuously in order to incorporate emerging changes into the service innovation (MacCormack *et al.*, 2001). Moreover, the short life span of information in highly dynamic industries increases the need for information awareness (Bhattacharya *et al.*, 1998; Moorman and Miner, 1997). However, external information acquisition is not enough. The obtained information must be shared within the project team, so that it can disseminate throughout the organization. Hence, we deduce the following proposition:

H3. The level of project learning will be positively related to the level of information awareness.

Information processing requirements and capabilities. Our case studies illustrated the importance of a clear fit between the information processing requirements and the information processing capabilities. We saw that all

projects had the technical opportunity to share information via Intranet. However, only the information and entertainment services project (IV) used the Intranet because the project leader stimulated the other members. Research has shown that potential users of knowledge platforms adopt the use behavior of their organizational climate (Purvis *et al.*, 2001). The studied telecommunications company lacked active championing and advocacy of the Intranet by senior management. Therefore, the possibilities of knowledge platforms have not been exploited. However, knowledge platforms that are created through the cost effective benefits of advanced information technologies can support essential information activities (Purvis *et al.*, 2001; Huber, 1991; Davenport, 1994). Nevertheless, although many organizations do have the technical capabilities to handle the information, very often the appropriate human processes are not instituted. Individuals are limited with respect to their cognitive processing skills (Simon, 1979; Davenport, 1994). Installing technical applications to facilitate information processing is not enough. Companies have to encourage their employees on the one hand to employ these technical opportunities and on the other hand to acquire and share information more frequently (Davenport, 1994; Cross and Baird, 2000; Jarvenpaa and Ives, 1994). Therefore, we expect that the larger the fit between the information processing requirements and the information processing capabilities the more project team members will learn (Daft and Lengel, 1986; Tushman, 1979).

H4. The higher the fit between information processing requirement and capabilities, the more the level of project learning will be enhanced.

Nature of communication. The nature of communication has a substantial effect on project learning. In the starting phase, the new service was only a vague idea. Hence, the project teams organized brainstorm sessions and creative meetings to shape their ideas. When an idea was generated, the team members had to clarify whether the development was technically possible and feasible. Thereafter, they started to design the service, followed by a testing phase. During all these phases, the nature of communication was characterized by a high level of creativity. In the later stages of the development process, the core service was defined and the team members mainly organized the launch activities. Every involved department needed to be instructed about its tasks and about the functioning of the service itself. Thus, we observed that the nature of communication changed. First, people mainly had brainstorming sessions and creative meetings where they generated ideas and developed a particular concept for the new service. In the later stages of the development process, communication became more formal for the coordination of technical and commercial aspects. This is in line with a proposed classification within innovation research (Souder and Moenaert, 1992; Hauptman, 1986; Blazevic and Lievens, 2003): innovative versus coordinative communication.

Innovative communication contains the creative search for solutions of problems. Thus, innovative communication includes finding answers to new evolving customer demands (Hauptman, 1986; Greenbaum, 1974).

Consequently, it should stimulate idea generation (Souder and Moenaert, 1992) initiating the new service development process. Through innovative communication companies react to new information coming from the environment, e.g. new technical possibilities, changing customer requirements, movements of the competitor. Thus, the project team is actively engaged in problem solving and new idea processing. Thinking creatively about evolving problems helps companies initiate the innovation process and stimulate information processing behavior.

Coordinative communication is associated with controls, orders, procedures and feedback between subordinates and superiors and across functional units. Thus, it handles the organizing of an innovation project through task division, individual responsibilities and conflict handling (Greenbaum, 1974; Hauptman, 1986). It is mainly needed to facilitate effective learning. Moreover, coordinative communication is needed to coordinate the different expertise, i.e. the specialized knowledge and abilities that each individual within the team possesses (Faraj and Sproull, 2000). Coordinative communication is especially important for an efficient handling of budgets and schedules. It is important to find a balance between innovative communication and coordinative communication, as both are essential for learning within service innovation. Thus, we expect the following:

H5. The level of project learning will be positively related to both the level of innovative and coordinative communication.

Antecedents of time-to-market

In our case study research analysis, we identified several factors influencing innovation speed. The following antecedents emerged from our analysis: project complexity, top management support, information power of the supplier and technological synergy.

Project complexity. The studied innovation projects revealed that project complexity has an important impact on time-to-market. The interviewed managers described the level of project complexity in terms of technological complexity, e.g. a lot of technically complex processes and products were involved, and the newness/innovativeness of the project, e.g. the project was a pioneering innovation. The virtual private network project (III) faced a very high technical level, which is one of the reasons why this project is regarded as being very complex. Technical problems were hard to solve and took a long time. The new content on SMS project (II) on the other hand was not regarded as complex mainly because it was involved with the development of a standardized "me-too" service. Another aspect influencing complexity is the size of a project. The new content on SMS project (II) had a small number of persons and departments involved, which resulted in clear task and role division contributing to a faster project life cycle time. Both, the new content on SMS and the information and entertainment services projects (II and IV), showed that working together with many persons on a technically complex service resulted in a lot of dysfunctional conflict among the team members,

especially since the team members originated from diverse backgrounds. The consequences of these different personal characteristics and the resulting frictions became increasingly evident throughout the project life cycle. Team members were less willing to share information or to communicate with each other. Moreover, the high turnover of team members during the VPN project caused uncertainty and ambiguity.

Thus, there are a number of factors that determine the level of complexity. Extant research illustrated that project complexity has a significant impact on cycle-time reduction efforts (Clift and Vandenbosch, 1999; Griffin, 1997). Project complexity can be defined as "consisting of many varied interrelated parts" (Baccarini, 1996, p. 201) and possesses two main features, differentiation and interdependency (Baccarini, 1996; Williams, 1999). With differentiation, we mean that many, different elements have to be considered. Interdependency on the other hand refers to the degree of interrelatedness between these elements. Consequently, the size of a project, the number of connections between project members, the radicalness of an innovation and the amount of uncertainty are important factors that may increase the project complexity. By reducing project complexity, companies can speed up the time-to-market of a service innovation. Thus, we deduce the following proposition:

H6. Time-to-market will be inversely related to the level of project complexity.

Top management support. Top management support is a substantial mechanism to accelerate time-to-market. The interviewed project team members elucidated that top management support is characterized by the commitment, involvement and resources that top management devotes to the project. In the voice and fax mail project, the company developed a standardized service that was an absolute necessity to compete in the market as every company offers these services. Therefore, this "me-too" service had very high priority for top management. Consequently, enough resources were assigned to the project to bring the basic service as fast as possible to the market. After the core service was launched, the additional service features had to be developed. These additional features however possessed only a low priority and got less top management attention. We observed that the core service was introduced in the market very quickly, whereas the development of the additional services took a long time. The other projects confirmed that the priority assigned to a project by top management influences the time-to-market of a service. The assigned priority determines the amount of resources a project will receive. Moreover, the motivation of the project team members suffers when top management assigns low priority to a project.

Thus, by assigning priority to projects and by establishing the strategic objectives, top management determines the degree of support a project team receives. The given support affects the assigned amount of resources as well as the motivation of project team members. Research has found that a medium amount of slack is good for innovation (Nohria and Gulati, 1996). Top management performs a motivating role in achieving competitive advantage

through a fast time-to-market innovation. The project team members will try to maximize their performance to finish the project in time. Therefore, top management support has a strong influence on the time-to-market of a new service (Kessler and Chakrabarti, 1999). Consequently, we expect the following:

H7. Time-to-market will be positively related to the level of top management support given to project teams.

Information power of the supplier. The information power of a supplier can have an essential negative impact on the time-to-market of an innovation. Supplier information power deals with the willingness of the supplier involved in service innovation projects to provide the project team with specific information. The voice and fax mail services project and the virtual private network project (I and III) experienced that the supplier did not provide the promised information. In both cases, the project teams were technically dependent on a specific supplier. However, the suppliers frequently did not deliver certain services, e.g. providing answers to technical questions. As the technical department could not proceed with the design of the service, it procrastinated the service development with respect to concept testing and design. Consequently, the market launch was postponed as well. Furthermore, the virtual private network project used hardware delivered by a supplier and needed specific operational information that the supplier was unwilling to provide. The company even tried to use governmental pressure, however, without the desired effect. As a consequence, the project team had to use a trial and error approach. When the project team finally received the technical specification, it became apparent that it was very complex. Thus, the technical department needed a lot of time to understand all details.

Nevertheless, project II – which had a fast time-to-market – showed that outsourcing can have a very positive effect on the cycle time of an innovation project. Certain tasks were performed by other parties, e.g. providing content to customers. This project showed that the right balance between insourcing and outsourcing is very important in order to control the supplier information power. Thus, companies should select their network partners carefully and have measures to prevent heavy supplier dependency. Eisenhardt and Tabrizi (1995) also ascertained that supplier involvement decreased innovation speed in the global computer industry, which is also a relatively dynamic market. Moreover, Ittner and Larcker (1997) found a negative relationship between supplier involvement and development time in product innovation projects, which contradicts other product development literature. Kessler and Chakrabarti (1999) discovered that externally generated ideas slow down innovation speed. They reason that projects without external involvement are faster as they possess a greater ownership (more control) and greater understandability and interpretableness of internally codified knowledge. These arguments also apply to the information power of suppliers. Hence, we postulate the following:

H8. Time-to-market will be inversely related to the level of supplier information power.

Technological synergy. Especially in high technology environments, innovation projects can benefit from a high technological synergy to increase the innovation speed. The virtual private network project (III) made use of bought hardware technology that did not at all fit to the needs of the project team. The technology the project team had to deal with was too complicated and did not correspond to the preferences and requirements of the project team. Nevertheless, the technology was already bought and the project team had to work with it. Contrary, the information and entertainment services project (IV) used a technology that had been developed at the parent company and was synergistic to the technological bases the company already incorporated. Additionally, the new content on SMS project (II) employed already present technology within the company, as it was a follow up project of the entertainment and information services project. Therefore, the existing technology fitted the requirements of the project team leading to an exploitation of their technical experiences obtained when developing this technology for the former project. Hence, technological synergy can influence the project life cycle. Technological synergy is defined as the existing fit between the needs of the project and the firm's existing technology (Lievens *et al.*, 1999a; Cooper, 1979; Cooper and Kleinschmidt, 1986). Technological synergy leads to a faster time-to-market as the technical development is less complex and less time-consuming. As many service innovations within the telecommunications industry are technology based, companies should exploit technological synergy. This leads to the following proposition:

H9. The time-to-market will be positively related to the level of technological synergy.

Project learning and time-to-market

Project learning is an essential factor for innovation speed. The interviewees explained that project learning occurred wherever project team members acquired, disseminated and used information. The more sources of information were used the higher the level of project learning. The voice and fax mail project (I) started when the company was just founded, thus, the project team members did not have established mechanisms for information processing activities. As a result, project learning was very low. In the new content on SMS (II) project, knowledge processes had been already instituted, as it was a follow-up project of the information and entertainment project (IV). Thus, specific learning mechanisms were already established. Consequently, the service was launched in the market quickly. In the virtual private network project (III) however, too much information processing occurred, leading to information overload, thereby extending the development time. Managers described time-to-market as the relative time it took a project team to introduce a new service in the market. The development time should be seen in relation to the original time schedule, the industry standards and comparable service innovation projects.

Throughout all projects, we could observe that a specific level of information processing activities influences the time-to-market positively. Hence, a certain level of learning has to be established before learning can contribute to time-to-market. First, information processing activities require time, leaving less time for new service development. Once the right learning mechanisms are instituted, efficient information processing leads to a cycle time reduction. Meyer and Purser (1993) emphasize that improving organizational learning is the core of a fast cycle-time strategy. By developing new mobile services, the project team members create a knowledge base, which serves as a platform for current and subsequent projects to react on events and trends in present and prospective markets. Mobile business opportunities (e.g. tracking consumer behavior) create growing knowledge content, but the question remains how to use it effectively. However, only a medium amount of information processing is appropriate in turbulent environments in order to speed up new service development. In turbulent environments information becomes obsolete more quickly (Bhattacharya *et al.*, 1998). The arising information load can only be managed through efficient information processing activities. Thus, proficient information processing activities are an absolute necessity in the fast development of new services. However, companies have to carefully manage their learning mechanisms as too much information processing may increase the development time because of information overload or information obsoleteness. Hence, we expect the following:

H10. Time-to-market will be curvilinearly (inverted U) related to the level of project learning.

A propositional framework

The goal of the present study was the development of a propositional framework concerning the critical antecedents of project learning and time-to-market in mobile service innovations. An exploratory case study research was performed in a Dutch mobile telecommunications organization. The research provided us with an empirical basis for theory development.

In turbulent environments, successful new services need valuable information processing activities that encourage innovation project team members to exchange their individual experiences. Project learning is stimulated through a project team design that facilitates learning prospects and encourages active learning behavior (Madhavan and Grover, 1998; Slater and Narver, 1995; Senge, 1990). Especially in turbulent mobile environments, companies need to design a fast, agile and boundaryless organizational setting in order to stay competitive (Tucker *et al.*, 1996). Thus, a flexible decision architecture constitutes a prerequisite for information rich processes (*P1*). Furthermore, the company should employ prior knowledge, experiences and skills, thus, project team memory is important (*P2*). Moreover, in dynamic markets new external information has to be spread throughout the project team, thus, the company needs high information awareness (*P3*). In order to cope with the turbulent environment, the information processing capabilities

should be coherent to the information processing requirements (*P4*). Additionally, communication is a necessary prerequisite for project learning (Lei *et al.*, 1999), as without information exchange employees cannot discover other experts' know-how (Ribbens, 1997; Schein, 1993). A proper balance of innovative and coordinative communication is essential, as both are needed for effective learning activities (*P5*).

In turbulent and dynamic markets, like the mobile market, new services have to be developed quickly (Tapscott *et al.*, 1998; Karagozoglu and Brown, 1993). Extant research has shown that a fast time-to-market can be a significant source of competitive advantage (Karagozoglu and Brown, 1993; Sherman *et al.*, 2000; Lynn *et al.*, 1999; Meyer and Purser, 1993; Kessler and Chakrabarti, 1996; 1999; Griffin, 1997; Bayus, 1997; Huff and Robinson, 1994). Especially in industries where new services have shorter life cycles, an ongoing effort to innovate in a fast manner is substantial to the survival of an organization. However, several factors influence the time-to-market of a service innovation project. Project complexity impedes a fast service innovation process (*P6*). Additionally, top management support is a necessary prerequisite to stimulate innovation speed (*P7*). The information power of the supplier has a negative impact on time-to-market (*P8*). Furthermore, companies in highly technical industries can accomplish essential benefits from technological synergy of various innovation >fk?projects (*P9*). Moreover, the ideal condition for a fast time-to-market is a medium level of project learning (*P10*). All relationships are summarized in Figure 2.

Conclusion and implications

In line with the information processing view of organizations, the examined project teams can be conceived as information systems that develop organizational knowledge. Organizations need to learn continuously in order to keep up with the aforementioned technological, competitive and customer trends (Lievens *et al.*, 1999b). The "fast" transformation of technological and market information into successful market-demanded outcomes is vital for the survival in a fast evolving mobile environment. As a result, the intersection of speed and knowledge is most critical during an organization's new product or service development. We have provided an in-depth investigation of this intersection of speed and knowledge, hence the intersection of project learning and time-to-market

Considering the characteristics of a mobile commerce business environment, we believe our model to have theoretical generalizability in dynamic, turbulent and uncertain environments where fast NSD has shown to be a strategic key success factor. Future operationalizations within such dynamic business settings will have to contribute and evaluate to the external validity of our model. A lot of industries dealing with the application and innovation of ICT will have to manage the challenge of continuing speedy innovation and the lock-in of knowledge. We therefore expect our propositional framework will

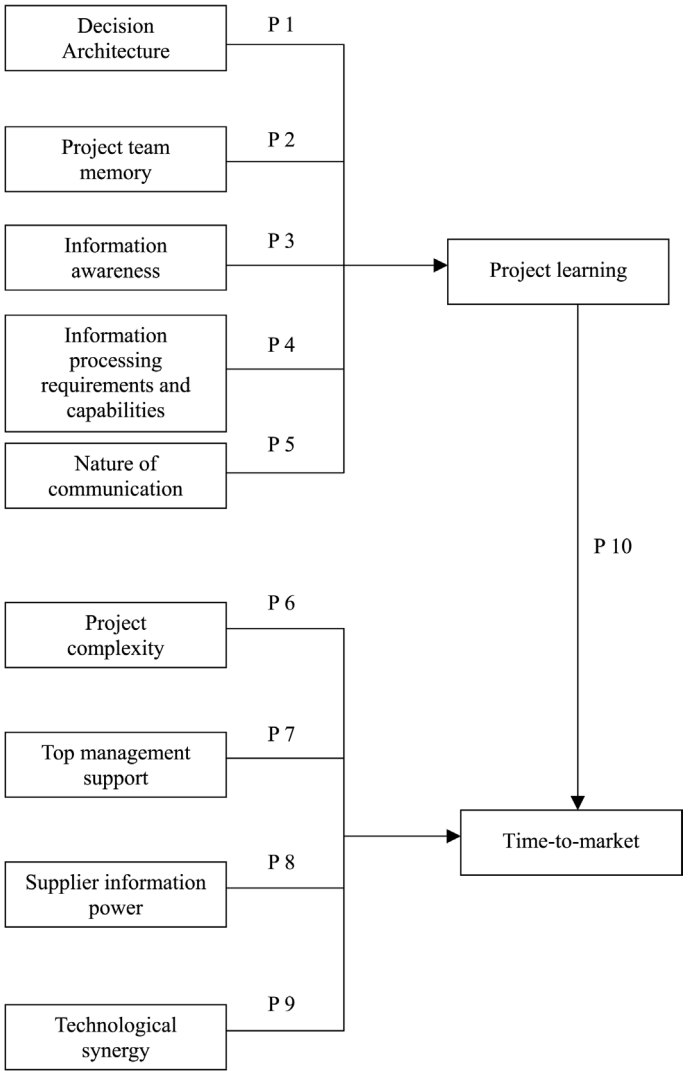

Figure 2.
Conceptual framework on the critical drivers of project learning and time-to-market

trigger the insight and extension of factors explaining a delicate balance between time-to-market and learning.

In terms of theory building we can also position our framework within the managerial relevance of the value chain. An increasing importance of time-to-market further pushes the deconstruction of the value chain into digital and tangible activities. Moreover, cost and efficiency purposes lead to an increased substitution of tangible activities with digital ones. This evolution will largely influence value creation in which information processing (i.e. learning) will constitute the value added of human processes. Therefore, we believe our

framework may contribute in the puzzle of determinants of thriving value creation both through fast new service development and learning.

Project learning involves information processing activities that build up a knowledge base. Hence, innovation management should steer balanced communication flows comprising both innovative and coordinative information. Moreover, information processing capabilities should match information processing requirements. The advanced information technology of the Internet and company-wide Intranets create opportunities for better communication via e-mail and sharing material online (e.g. Microsoft Netmeeting). Thus, more information can be shared with a wider audience. Despite these advantages, our case studies demonstrated that more communication channels could be counterproductive to learning in some situations. Project team members have to deal with information overload while human capabilities sometimes cannot cope with all the extra information leads provided through IT-infrastructure. Therefore, coordinative communication is necessary to handle the increasing amount of information. Innovative communication is necessary during the service innovation process, as successful innovations need experimentation and improvisation (Moorman and Miner, 1998; Eisenhardt and Tabrizi, 1995). The innovation process contains a lot of uncertainty that the firm has to manage by supporting creativity and the exchange of ideas. Hence, the organizational climate during the new service development is essential for stimulating project learning. Organizations should provide some slack resources that ensure the time for creativity and experimentation (Nohria and Gulati, 1996). Moreover, the organizational milieu should support employees by allowing active participation, thereby creating the best conditions for vigorous learning behavior. Learning is a social process that establishes human linkages between employees. Consequently, learning should be deeply embedded in the organizational identity in order to institutionalize shared values and meanings that in turn diminish misunderstandings. Furthermore, employees will implement decisions better when they have contributed in the decision-making process. Participation supports the motivation of employees as they can achieve self-fulfillment and a higher level of job satisfaction. Hence, a more flexible and participative decision-making will support project learning.

Project team memory is another important factor as various team members can exchange their expertise and know-how, hence previously acquired knowledge. Moreover, when recruiting personnel, managers should select employees with different backgrounds and skills so that other employees can profit from their knowledge. Involving people from different departments in one project opens up boundaries that lead to a stimulating working atmosphere. Considering the turbulent nature of the telecom market and the high turnover of employees, management should pay more attention to the explicit "lock-in" of knowledge.

Additionally, innovation management should stimulate information awareness through cross-functional interfaces and the sharing of internally or

externally acquired information between project team members. Employees should have a better insight in the activities of the whole company. Thus, organizations should support employees by providing opportunities for training and rewarding for creativity in order to encourage the transfer of knowledge. Learning behavior should be integrated in job descriptions and evaluations, i.e. the yearly review about employees' performance. Establishing a positive learning climate is a sustainable competitive advantage that is hard to imitate by competitors.

Managers within the mobile industry have to focus on speed to market as a strategic priority. A major prerequisite is top management support and priority given to a project. As top managers give future directions, they should stimulate the exchange of ideas by showing their own interest and support with resources and investments. Considering the strong supplier dependencies that still exist within the mobile industry, future relationship building/ management within the networks of the digital economy (the so-called electronic business platforms) should leverage potential information asymmetries.

Innovation management needs to handle project complexity by coordinating crucial functional and company interfaces. Managing the appropriate communication network that will fit the information processing requirements is an essential responsibility within innovation management. Moreover, innovation capacity should be enhanced by exploiting technological synergies during the service innovation process.

A medium level of learning is the optimal condition for a fast time-to-market. Organizations should establish formal and informal linkages between different departments and should ascertain enough resources in order to engage their employees in information processing activities. However, managers have to be aware that too much information creates an information overload, which will impede time-to-market. Moreover, especially in turbulent environments managers have to encourage their employees to actively perform information processing in order to avoid information obsoleteness.

Furthermore, the service innovation process is not only supposed to be fast but also very flexible, as new acquired information should be incorporated also in late stages of the innovation process. Research has shown that the classical stage gate process is very effective in stable environments (Cooper and Kleinschmidt, 1986), but its value in turbulent environments has been questioned (Bhattacharya *et al.*, 1998; Iansiti and MacCormack, 1997). A clear limitation of the stage gate process is that:

> It assumes that all information about potential design choices is known or can be discovered during concept development (MacCormack *et al.*, 2001, p. 134).

Thus, managers should try to apply a concurrent engineering approach to achieve a high flexibility for reactions to changes in the market also in later stages of the development process.

Limitations and suggestions for future research

We used multiple sources of information and an iterative analysis procedure in order to increase the validity of our constructs and the presumed correctness of our inferences (Yin, 1994). The external validity of our case studies should point to analytical generalizability, which involves replication logic. The objective of the present case study has been to postulate research propositions rather than testing them. Therefore, it is necessary to test the propositional framework with a more conclusive research method, e.g. an *ex post facto* survey or a longitudinal study. The latter approach may be advantageous as it can focus on learning and speed throughout the whole project life cycle.

Moreover, our unit of analysis within the case study research design has been the project level (i.e. the new mobile service innovation) and preliminary generalizations can hence only be formulated on the project level. Nevertheless, the nature of the antecedents discovered for learning relate strongly to organizational design. Consequently, future research designs should incorporate different units of analysis comprising both variables on the project and the organizational level.

In addition to methodological limitations, the present study is also limited with respect to theoretical clues. Although it stresses the importance of time-to-market as an important success factor of innovation success, it should be noted that the pure strive for shortening the innovation cycle time may lead to an overemphasis of uncreative incremental innovations. Although time-to-market is an important determinant of innovation performance, organizations should also consider other indicators, such as quality and costs of the innovation. Time-to-market is not supposed to be the pure strive for shortening the project life cycle, but should be approached and measured by using both a time-related and a goal-oriented measure where the latter should be stressed. Hence, future empirical research should focus on a broad spectrum of innovation speed measures.

Moreover, project team memory supports the building of absorptive capacity and is thus favorable for project learning. Past experiences of past projects should be used to support the avoidance of "re-inventing the wheel" (Drew, 1994). Moreover, project teams should develop "transactive memory" which enables expertise coordination. Transactive memory helps teams to locate certain knowledge areas of team members thus reducing cognitive load (Faraj and Sproull, 2000). However, the question arises whether too much prior knowledge detracts from creativity, thus leading to only minor incremental changes. Moorman and Miner (1997) found that high memory levels neither improve nor revoke product creativity. They argue that the memory level may be less important than the flexibility a firm incorporates when handling its knowledge. Thus, it is essential to not only rely on past experiences but to incorporate mechanisms that enhance flexible processing of new valuable information. Hence, future research is needed in order to define the appropriate level of project team memory and the flexible handling of knowledge within organizations.

We proposed an inverse relationship between supplier information power and the time-to-market of a project. However, in the digital economy companies need to establish networks of suppliers, distributors, commerce providers and customers. These so-called electronic business communities (EBCs) build platforms for collaboration that support innovations within the mobile world (Tapscott *et al.*, 1998). These EBCs however must be carefully managed as suppliers or content providers often possess necessary information that is needed for fast service development. Thus, supplier involvement can be helpful but it involves greater coordination requirements (Kessler and Chakrabarti, 1999). Future research should clarify which level of supplier involvement is most favorable and how organizations can achieve a beneficial supplier involvement.

Moreover, future research could incorporate other potentially important antecedents of project learning and time-to-market. Further, it is necessary to empirically confirm the critical antecedents and the relationship between project learning and time-to-market during the service innovation project life-cycle.

Notes

1. GSM is the abbreviation for "global system for mobile communication". It is a globally accepted standard for digital cellular communication originating from a European initiative to create a common European mobile telephone operating at 900MHz. Today, GSM has over 120 million users worldwide and is available in 120 countries (Whatis.com, 2002).
2. UMTS is the abbreviation for "universal mobile telecommunications service" and is supposed to become the standard for mobile users in the near future. The advantage of UMTS is the fast, broadband transmission of text, voice, video and multimedia data at a rate of up to two megabits per second. Sometimes it is also called the "third-generation" (3G) mobile service (TechTarget, 2002).
3. Following MacCormack *et al.* (2001), uncertain settings mean markets in which future evolutions and technologies are difiicult to envisage. Dynamic environments are those in which these evolutions arise rapidly.
4. According to Peter (1981, p. 134) we can describe a construct as "a term specifically designed for a special scientific purpose, generally to organize knowledge and direct research in an attempt to describe or explain some aspect of nature".

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