Michael Haas

Management of Innovation in Network Industries

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Michael Haas

Management of Innovation in Network Industries

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Abbreviations

AMPS ..... Advanced Mobile Phone System
ANSI ..... American National Standards Institute
CDMA ..... Code Division Multiple Access
CDMA2000 ..... CDMA version of IMT-2000
CDPD ..... Cellular Digital Packet Data
CHTML ..... compact Hypertext Markup Language
DoPa ..... DoCoMo Packet Network
DP ..... Design Parameter
DVD ..... Digital Versatile Disk
ETSI ..... European Telecommunications Standards Institute
FR ..... Functional Requirement
GPRS ..... General Packet Radio System
GSM ..... Global System for Mobile Communications
HDML ..... Handheld Device Markup Language
HTTP ..... Hypertext Transfer Protocol
IMT-2000 ..... International Mobile Telecommunication 2000
IP ..... Internet Protocol
ITU ..... International Telecommunications Union
Kbps/Mbps ..... Kilobits/Megabits per second
MIDI ..... Music Instruments Digital Interface
MHP ..... Multimedia Home Platform
MMC ..... Mitsubishi Mobile Communications
MML ..... Mobile Markup Language
MMS ..... Multi Media Messaging
NMT ..... Nordic Mobile Telephony
NPD ..... New Product Development
OMA ..... Open Mobile Alliance
OMTP ..... Open Mobile Terminal Platform
PDC ..... Personal Digital Cellular
PMC ..... Panasonic Mobile Communications
PTT ..... Public Telephone and Telegraph
SMS ..... Short Message Service
TACS ..... Total Access Communication System
TCP ..... Transmission Control Protocol
TDMA ..... Time Division Multiple Access
TTML ..... Tagged Text Markup Language
UMTS ..... Universal Mobile Telephony Standard
UP ..... Unwired Planet (now Openwave)
URL ..... Unified Resource Locator
WAP ..... Wireless Application Protocol
W-CDMA ..... Wideband Code Division Multiple Access
WML ..... Wireless Markup Language
WSP ..... Wireless Session Protocol
WTP ..... Wireless Transaction Protocol
xHTML ..... extensible Hypertext Markup Language

1. Introduction

1.1 Motivation and Research Questions

This work seeks to further our understanding on the management of innovations in network industries. Although the economics of network markets like telecommunications, Internet, email, media, computer, and service operations in banking, legal and airline industries have become a major field of economic research; knowledge about how to manage innovation within these markets is less advanced (HOBDAY et al. 2000: 793; CHESBROUGH 2003: 198). The goods and services of these industries regularly manifest themselves as complex system products, which are composed of multiple mutually dependent components and often supplied by different industries (HOBDAY 1998: 691; TIDD 1995: 308). Innovation processes associated with complex systems products, therefore, display a systemic character and the issue of how to coordinate the diverse but nevertheless complementary inputs poses a major challenge for innovation management.

The issue of how to organise complex innovation projects, however, is still open for debate: A broad range of organisational forms—e.g. vertical integration—CHESBROUGH and TEECE (1996: 68), TEECE (1996: 205), CHESBROUGH and KUSUNOKI (2001: 227); decentralised networks—BRESNAHAN and GREENSTEIN (1999: 13–14); DE LAAT (1999: 162) LANGLOIS and ROBERTSON (1992: 310); project-organisations—HOBDAY (2000: 892) has not only been theoretically derived, but is reported as well in practical use. The observation that different means are suited to solve similar problems raises questions that point to the heart of comparative economic research: why do alternative solutions emerge? Which implications have different organisational forms on the performance of innovation processes? Are there better or worse solutions?

The present work attempts to shed light on these yet unresolved issues by conducting a comparative analysis of the introduction of mobile data communications in Japan and Europe. Mobile data communications is a case in point, as Japanese and European firms chose different ways to organise the innovation processes and also displayed different innovative performances.

In the later half of the 1990s European, US-American and Japanese firms took up the challenge of bringing Internet access to mobile phones. In terms of the technical side of the innovation processes, the following problems had to be solved: how could Internet Services which had been tailored for large screens and desktop PCs be run on significantly constrained devices in terms of computing power, memory or storage capacity, screen size and networks with only marginal data transportation functionality? Answering these questions required major modifications and extensions of the then existing mobile telecommunications systems, encompassing all its components.

Although European, US-American and Japanese firms faced similar challenges the outcome of the innovation projects differed significantly. While Japanese firms created a mass market for mobile internet services—with NTT DoCoMo's *i-mode* ser-

vice taking the lead but its smaller competitors *EZweb* and *J-Sky* nevertheless being successful—European and US-American players had to face a disappointingly low customer acceptance. The dramatic performance gap, i.e. the fast user growth in Japan, soon attracted a large number of practitioners and researchers alike trying to explain the Japanese success story (e.g. ANDERSEN 2002b; BALDI and THAUNG 2002; DATAMONITOR 2002; DEVINE and HOLMQVIST 2001; FRANSMAN 2002; FUNK 2001; LINDMARK and BOHLIN 2003; PIKULA 2001; STEINER 2003; VESA 2003). This body of literature has already achieved a sound description of how Japanese approaches towards the innovational challenges differed from European approaches. For those wishing to copy the Japanese strategies these insights might be sufficiently comprehensive. Otherwise, why should one bother to put further effort in researching the Japanese success story?

The effort is justified because of two reasons: firstly, previous research could show only in a rudimentary way how the approaches differed, and secondly utterly failed to answer why these differences mattered. For example, among many factors, which had been identified by earlier research, it was also pointed out that Japanese firms had chosen significantly different approaches towards managing the innovation processes. In Japan mobile network operators initiated and controlled the innovation projects. As each network operator entertained exclusive relations with selected suppliers of system components, three competing and incompatible service platforms were introduced into the market. In contrast to the closed Japanese approach, innovation was driven in Europe by an open alliance of the leading technical suppliers. This strategic alliance—to be known as the Wireless Application Protocol Forum (WAP)—aimed on creating a standardised platform that could be sold worldwide to network operators.

The correlation between a different organisational approach and market success led some authors (e.g. VESA 2003: 22) to conclude that a closed, quasi-integrated approach is better suited to overcoming the challenges associated with innovations in network products. This conclusion, however, is premature, as it does not go beyond merely functionalist reasoning. This conclusion, furthermore, has to be qualified. Since the introduction of mobile data communications in 1999, the Japanese mobile industry was considered to be at least 18 months ahead of its European counterpart. Industry experts (SCUKA 2003; RESPONDENT E 2004), however, point out that European players have recently caught up and closed the gap considerably. Drawbacks in the Japanese model are also becoming visible. It is common wisdom in the mobile industry—a point openly admitted even by Japanese interviewees—that the exclusive relations between handset suppliers and network operators leads to smaller batch sizes and thus higher handset prices. The European model resting on open standardised solutions allows—besides the cost advantage—for a broader participation in the innovation process. Although, for example, Japanese network operators were the first to introduce Java-Applications, the quality of standardised Java-Applications has surpassed the quality of the proprietary Japanese solutions, because the open model could attract a larger number of complementary developers (RESPONDENT G 2004). The comparative

advantages of either the Japanese or the European approach, therefore, seem to change over time and to depend on specific context variables.

A further interesting, yet unexplored point is the adaptation of the approaches employed by European as well as Japanese players. A certain degree in convergence in the organisational forms can be observed. Major European operators have adopted—at least to some extent—the Japanese model. NTT DoCoMo on the other hand seems to head for a more open approach, joining the Open Mobile Terminal Platform (OMTP) Group—an international initiative of mobile network operators aimed at creating an open innovation network. Building upon these arguments, the present work aims to elaborate on previous research by addressing the following questions:

1. Which alternative solutions did Japanese and European actors apply during the development of the first mobile Internet systems? How different are the solutions?
2. How can the emergence of different solutions be explained?
3. Which implications do the differences have for innovative performance? Do differences matter and why do they matter?

The main contribution of this work lies in its attempt to answer the third question. Its central goal is to establish and clarify the causal links between the differences in the solutions and the observed innovative performance. Thus the insights of previous research can be advanced to a higher level of explanatory power. So far arguments have not surpassed the level of simple functionalistic reasoning, i.e. the Japanese model must be superior as it has been accompanied by a superior market outcome. Clarification of causal linkages between alternative solutions and performance is also the prerequisite for any explanation of convergence processes as well as any generalisation beyond specific cases.

A further contribution lies in a more detailed description of the Japanese and European cases. Previous research has overwhelmingly focused on the diffusion phase of the *i-mode* service, which was introduced by NTT DoCoMo. To the best of the present investigator's knowledge the innovation processes associated with the establishment of the technical platform (a prerequisite for the diffusion success) has been widely neglected, not only concerning the competitors of NTT DoCoMo but also concerning the *i-mode* service itself. A notable exception is SHIRAKURA's series of articles (2002a, 2002b, 2002c, 2002d, 2002e, 2002f, 2002g, 2002h, 2002i, 2003a, 2003b, 2003c). The establishment of the WAP-Platform and its introduction by European network operators has also been neglected by research so far—with SIGURDSON 's case study (2001) being a notable exception. A more detailed inspection of the *i-mode* competitors appears to be overdue as it is not yet clear to what extent the approaches of other Japanese mobile network operators are similar to that of NTT DoCoMo. It cannot be ruled out *a priori* that the innovation management of KDDI or J-Phone (now Vodafone) might not present even better solutions. Concerning the WAP case it has also not been clarified what went wrong, as other network industries are said to have fared reasonably well with an open network approach.

By addressing the third question a foundation is laid for generalising the findings beyond the mobile telecommunications industry. Previous research has vigorously sought to give managerial recommendations to European actors of the mobile telecommunications industry but failed to ask what can be learned in general about innovations in network industries.

1.2 Research Focus and Methodology

1.2.1 Clarification of Terminology and Focus-Setting

The plethora of definitions for the term innovation calls for a clarification of the terminology before proceeding to set out the research methodology. Although many sources have pointed out the problem of ambiguity resulting from the multiple approaches towards conceptualising innovation, innovation research has not yet found consistency in its labelling of the phenomenon (e.g. GREEN et al. 1995: 203; HAUSCHILDT 1997: 1-2; GARCIA and CALANTONE 2002: 110). This thesis adopts a definition of innovation as proposed by GARCIA and CALANTONE (2002: 112):

> 'Innovation' is an iterative process initiated by the perception of a new market and/or new service opportunity for a technology-based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention.

Another term prone to ambiguity in concepts can be observed for the expressions 'performance' or 'success'. Previous research on mobile data communications has judged the Japanese case to be a success story based upon the observation that end users have enthusiastically adopted the new services. It cannot be overemphasised that innovative performance seen in this way is a manifestation of a successful diffusion process. Treating innovative performance as being equal to diffusion performance, however, has serious implications for any research object attempting to explain the Japanese success story. As ROGERS (2003) has vividly shown, diffusion of an innovation must be considered as a very complex social process affected by a broad range of variables. Any explanation of the Japanese success story therefore would have at least to incorporate the most influential factors pointed out by diffusion research. Among others, these would include (1) the actual merit of an innovation, (2) the extent the merits can be perceived or observed by potential adopters (3) the communication channels used to promote the innovation, (4) the nature of the social system the innovation is introduced into and also the (5) innovativeness of the adopters, i.e. the consumers (ROGERS 2003: 220, 297; NELSON et al. 2004: 682). It is quite self-evident that a comparative model attempting to be comprehensive on a nationwide or even an international scale would amount to a rather complex theoretical construction far beyond the scope of a single research project.

Complexity can, however, be reduced to a manageable degree by focussing just on one of the factors. The perceived attributes, especially the quality of an innovation, present a good starting point as these are fixed by the time of market launch and are thus a major prerequisite for the diffusion process (ROGERS 2003: 220). Furthermore,

the quality of a new product has been unanimously acknowledged as a determinant for success by empirical research on the success and failure of innovations (VAN DER PANNE et al. 2003: 317). In line with the arguments above, innovative performance is defined for the present thesis as the outcome of the innovation processes at the time of market launch. According to this definition, the scope of this research project in terms of the procedural dimension of innovation is confined to the time range between the fuzzy front end of a new product development project and the first introduction of the new product into a market.

Furthermore, the present work sets its focus on the issues of inter-firm cooperation during the innovation stage. Mobile data communications—as in the present case of a complex system product—were established by the input of multiple firms. There had been a division of labour in the innovation process, requiring to some extent joint problem-solving activities and coordination of the various outputs created by intra-firm innovation processes. In other words, the unit of analysis is not a single firm and its departments concerned with innovation (like R&D or Marketing), but the whole innovation system consisting of all important economic players involved in the new product development. For this reason, innovation teams composed of multiple firms will be at the centre of the analysis. NTT DoCoMo, for example, teamed up with NEC, Panasonic, Access, Fujitsu and Mitsubishi to develop the *i-mode* platform (SHIRAKURA 2002c: 244; 2002e: 174–175). Likewise, Nokia, Ericsson, Unwired Planet and Motorola founded the core team of WAP development in Europe (SIGURDSON 2001: 7–8).

1.2.2 Research Design

The present work uses an inductive empirical approach applying the case study method as outlined by EISENHARDT (1989) and YIN (2003b). The case study itself follows a multiple-case design (YIN 2003b: 46–54), comparing several teams of multiple firms, their efforts, and the resulting outcomes. An exemplary case study involves the following steps: (i) Case selection, that is defining what the 'case' is, (ii) construction of an analytical framework that provides guidance for the process of (iii) data collection, (iv) data analysis and (v) writing of a case study report (which is this thesis). The following paragraphs briefly describe how these steps were carried out in the course of this case study. The outline of the case study report, i.e. the outline of this thesis will be presented in the next section.

1.2.3 Case Selection

The introduction already hinted why the theme chosen for thesis was a study of the introduction of mobile Internet services with respect to the 'cases' of Japan and Europe: Both regions were selected as cases because (i) they experienced completely different innovative performance and (ii) innovating firms in both areas tackled the innovational challenges with totally different approaches. Main unit of analysis are the joint-innovation projects of multiple firms that attempted to develop and to commercialise mobile Internet services.

In Japan three projects or teams could be identified as Japanese network operators brought three incompatible mobile Internet systems to the market and cooperated on exclusive terms with selected technical suppliers. The three teams were (i) the *i-mode* alliance around NTT DoCoMo, Panasonic Mobile Communications (PMC), NEC, Mitsubishi Mobile Communications (MMC), and Fujitsu; (ii) the *EZweb/EZaccess* project made up by DDI, Hitachi, IDO, Kyocera and Unwired Planet (now OpenWave) and (iii) the *J-Sky* cooperation of Digital Phone Tôkyô (later J-Phone and now Vodafone K.K.) and Sharp.

Speaking of a European case is actually imprecise. On the one hand, Europe is first of all a vast region spread across many countries. Any case study about this multitude of countries would be limited in depth and probably would not be able to cover the diversity in the countries in sufficient detail. On the other hand, network operators in all European Union member countries deployed the same technology to deliver mobile Internet services, namely systems that were based on WAP. Development of WAP took place within the WAP Forum, a private standardisation body that listed firms from all over the world as its members and was established by Ericsson, Motorola, Nokia and Unwired Planet. These observations indicate that WAP is not only a European but also a worldwide phenomenon. WAP can nevertheless be treated as a European case because its main drivers were European handset manufacturers. A further reason why the case is titled 'Europe' arose from demands of the interviewed firms and individuals. The thesis analysed in depth market introduction of WAP services in one specific European country and consequently it would have been more precise to state the name of that country. However, the interview partners that contributed the main empirical data insisted on full anonymity. Disclosing the analysed country would have implied also disclosing the interviewed firms, as the number of network operators and handset manufacturers in each European country is limited. Insiders in the European mobile communications industry therefore would have had no difficulties in tracking which firms had been interviewed. For these reasons the thesis will speak of the European case, despite being aware that the term entails a certain ambiguity.

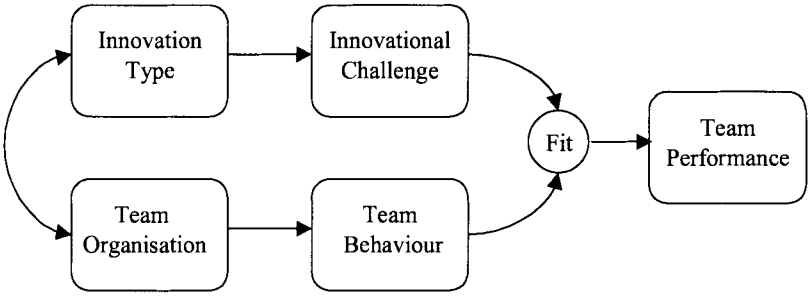
1.2.4 The Analytical Framework

In accordance to YIN's recommendation (2003a: 3) an analytical framework was set up before commencing the case study. Construction of the framework guiding the inductive data-gathering approach was inspired by insights from the new product development (NPD) literature. Research on NPD has long recognised the crucial role of teams in innovations and devoted considerable scientific attention to them. Work in the field of NPD, however, has traditionally focused on a single commercial firm (KAHN et al. 2003: 199). Models proposed by NPD researchers (e.g. MCDONOUGH III 2000: 233; MONENAERT et al. 2000: 373; LEENDERS and WIERENGA 2002: 312) analysing human beings as team members, therefore, had to be modified in order to incorporate firms as individual team members. The modification of the original NPD frameworks was based on a broad review of literature. Various lines of research were analysed and synthesized into a set of generative questions guiding the further analysis. The analytical framework thus evolved beyond a mere guiding structure into a set

of working-hypotheses. The core working-hypothesis of this thesis is: *Differences in innovative performance are a result of differences in the fit between pursued management approaches and the specific challenges of a given innovation.* The framework is made up of the following sub-hypotheses and building blocks (Figure 1 represents a graphical summary):

1. Several firms have perceived a market opportunity for mobile data communications and decide to jointly develop the technological invention into a marketable product (mobile data communication services). At this point the *team organisation* of the joint innovation project will be fixed. The firms choose with which players to team up, to what extent resources will be devoted to the project, what competences will be brought in and what the division of labour between the team members will look. Of course, the structure of the industry, existing business or competitive relations influence these choices. Establishment of the team organisation takes place at the outset of the project and creates the foundation on which the innovation activities take place (see MCDONOUGH III 2000: 223).
2. The *innovation type* describes the nature of the innovation activities and answers, for example, the question to what extent mobile data communications incorporate technologies the team members are unfamiliar with, or to what extent market demand is uncertain. The innovation type is thus, on the one hand, contingent on the team members' competencies and capabilities. High technological uncertainty combined with high market uncertainty, on the other hand, implies a high risk that the product to be developed will not become a commercial success. Seen from this perspective, the innovation type can also impact on the stage-setting phase as potential team members might become reluctant to invest in a risky project. The framework assumes therefore *a reciprocal relationship between team organisation and innovation type.*
3. The innovation type (affected by team organisation) influences the nature of the *innovational challenges* to be overcome in order to turn the invention into a marketable product. An innovation displaying high technological uncertainties, for example, makes the progress of the development activities less predictable placing increased information and communication demands on the team members (see OLSON et al. 2001: 263).
4. *Team behaviour* addresses the actual conduct of innovation activities by the team. Typical questions to be analysed are: How well do team members cooperate, how deep is their commitment for the joint innovation project (see MCDONOUGH III 2000: 226).
5. The *fit* between team behaviour and innovational challenges are thus assumed to translate directly into *team performance*, e.g. the outcome of the teamwork in terms of speed (product development time) and the quality of the product brought to market.

Figure 1: *Analytical Framework*



1.2.5 Data Sources

The case study reported in this thesis draws primarily on two sources of empirical evidence: (i) written sources (including existing research literature but also data provided by trade journals, press releases etc.) and (ii) semi-structured interviews.

Although the former source had already provided comprehensive insights into team organisation and team performance, it revealed almost no data about innovation type, innovational challenge and team behaviour. Therefore, semi-structured interviews were conducted with participants in the innovation processes and also with general industry experts to learn more about these unaddressed issues.

The case study conducted in total 30 interviews with employees of 22 firms and institutions. Table 1 lists the interview partners and their employers. In selecting interview partners two issues were carefully considered: Firstly, interviews should be conducted (as far as possible) with at least one firm from every interest group (operators, handset suppliers etc.) that were members of a given team. Secondly, as far as possible employees who had directly participated in the innovation processes needed to be interviewed.

People directly involved in the innovation process were identified primarily through other interview partners and only on rare occasions through written sources such as trade magazines. Some firms therefore had to be visited on more than one occasion. In the case of the European handset manufacturer multiple interviews were justified, because several departments had been part in the development of WAP enabled handsets and network components. Interviews were conducted with personnel that had been in charge of browser technologies, WAP gateways, handset software and employees who had actively participated in the WAP Forum. Detailed information on key informants can be found in the appendix (see A.1). Interview partners classified as industry experts were employees of research institutes, industry associations or retirees who used to work in the mobile telecommunications industry. Interviewees from this category have in common that they are not directly involved in the daily operations of the mobile industry, but are nevertheless able to provide valuable background information. The interviews were conducted between January 2003 and December 2004. Each

interview had on average a duration of one hour. Most interview partners rejected recording of the conversation and therefore only field notes were taken. Of the interviews, 26 were conducted face-to-face and four were by telephone. Occasionally personal e-mail contact and questionnaires supplemented the interviews. All interview partners had been provided with protocols of the conversation allowing them to check for misunderstandings.[1] Most interview partners, however, waived the opportunity to comment upon the protocols.

Table 1: *List of Interview Partners*

Kind of Firm	Name of interview partner and firm	Firms	Interviews
Network Operator			
Japan	Takahashi, Makoto (KDDI); Niori, Shingo (KDDI); Hotoda, Eiji (KDDI); Yamamoto, Tetsuji (NTT DoCoMo); Tetsuya, Yamashita (NTT DoCoMo); Macdonald, David J. (NTT DoCoMo); Murota, Kazuaki (formerly NTT DoCoMo); Odate, Hitoshi (formerly NTT DoCoMo); Ohta, Hiroshi (formerly J-Phone)	3	7
Europe	Respondent A (Operator A); Respondent B (Operator B); Respondent C (Operator C)[2]	3	3
Handset Supplier			
Japan	Ikawa, Keiichi (PMC); Katô, Atsunobu (PMC); Hiraoka, Kaoru (Fujitsu); Kuwamoto, Hideki (Hitachi); Ozaki, Tomochika (Hitachi); Uematsu, Takeo (Sharp)	5	5
Europe	Respondent D (European Vendor A); Respondent E (European Vendor A); Respondent F (European Vendor A); Respondent G (European Vendor A)[2]	1	4
Browser Supplier			
Japan	Kamada, Tomihisa (Access); Ôshiro, Akiko (Access)	1	2
Europe	Schmänk, Mathias (Access Systems Europe)	1	1
Content Provider			
Japan	Terada, Shinji (Cybird); Shimada, Keiji (Cybird)	1	1
Europe	Fürtig, Jörg (imaHima Europe)	1	1
Industry Expert			
Japan	Kishihara, Takamasa (Mobile Content Forum); Mochida, Yukou (Fujitsu Laboratories); Takano, Takeshi (Fujitsu Laboratories); Satoh, Yusuke (Sharp); Fujiwara, Masahiro (KDDI Research)	4	4
Europe	Kanda, Yusuke (*i-mode* Europe); Murase, Atsushi (DoCoMo Euro-Labs)	2	2
Total		**22**	**30**

[1] All interviews and written communication were conducted in the native language of the interviewee. The summaries of the interviews, however, were written in English.

[2] These European interview partners made full anonymity of their identity and the identity of their employers a precondition for an interview appointment.

1.2.6 *Methodology — Data Collection and Analysis*

The interview partners were approached with a semi-structured questionnaire that was modified in the course of the case study. Although modification of a questionnaire is prohibited in the course of large-scale quantitative surveys, it is an explicit part of the approach towards analysis of qualitative data that was applied here (STRAUSS 1987: 14–20). Modification of the questionnaire was necessary as the structure of the problem to be analysed only gradually emerged. Development of the questionnaire proceeded as recommended by STRAUSS and CORBIN (1990: 30):

> The very first interviews or field notes should be entirely transcribed and analyzed before going on to next interviews or field observations. This early coding gives guidance to the next field observations and/or interviews.

After several modifications the set of questions guiding the interviews reached its final form as shown in Appendix A.2. The questionnaire contains a large number of questions, but that does not mean that every question was posed to every interviewee. Firstly, interview partners had different roles in a given project (e.g. network operator versus handset manufacturer) and therefore it would not have made sense to raise all the questions. Secondly, questions that had been consistently and comprehensively answered by previous interviews and/or literature about historical and technical facts were omitted in later interviews in order to spend more time on less understood topics. Less relevant questions dropped particularly in the case where an interview partner volunteered very detailed and interesting information about a certain topic.

The interviews were analysed by applying the methods of 'qualitative data analysis' as proposed by STRAUSS (1987). This means that information provided by interviewees was sorted or coded according to categories. A basic set of categories had already emerged out of the first interviews and a general literature review (see Chapter 2), leading to establishment of the analytical framework as shown in Figure 1. The data gathered in the course of later interviews were then related to each of the basic categories (coding). The results of this first coding step were summaries or protocols of the interviews that were also sent out to the interview partners allowing them to add further comments. These summaries were revisited and lead to refinement of the basic category schema by adding more detailed sub-dimensions (e.g. team organisation → number of members → cooperative ties between members or team behaviour → standardisation of interfaces → cooperation versus conflict etc.). In a third step, causal relations between these categories were hypothesized and as far as possible verified in further interviews (see STRAUSS 1987: 22–39; also ALTHEIDE 1996).

The following topics provide a brief example of this approach: At first the specific innovational issues of mobile Internet services were empirically analysed, providing evidence that organisational problems were at the heart of the challenges. This observation raised the question which kinds of organisation would be 'better' suited to manage the observed problems. Provisional answers to this question were theoretically derived by deduction establishing an emerging (if still primitive) theory and provisional hypotheses that provided more refined guidance for further empirical analysis.

Each empirical step was thus directed by insights from previous data analysis and theoretical reflections. The advantage of this approach is that:

> [T]he theory is not just discovered but *verified*, because the provisional character of the linkages – of answers and hypotheses concerning them – gets checked out during the succeeding phases of inquiry with new data and new coding.(STRAUSS 1987: 17, original emphasis)

The inherent weakness of a contingency approach, which is manifested in the research design of this thesis, can thus be overcome. Contingency approaches have been criticized because they just hypothesise causal linkages between structure and performance but fail to verify the hypothesized causal relations (see for a more elaborate critique KIESER 2001).

1.3 Outline of the Thesis

The structure of this thesis reflects the structure of the analytical framework. The thesis is divided in two sections: A general section about innovations in network industries (Chapter 2) and a specific section about the case of the mobile Internet (Chapter 3 to 6). The individual chapters of the specific part successively address the building blocks of the framework.

Chapter 2, the general section, presents a review of various lines of literature providing a general overview of issues related to management of innovations in network industries. The main goal of the chapter is to provide the reader with a basic understanding of the specific innovational challenges and approaches to mastering them. The chapter also elaborates the analytical framework highlighting questions raised by previous research that serve as an initial guide through the process of data collection and analysis.

Chapter 3 is the first part of the empirical study, but also lays the theoretical basis for a more refined directed inquiry in the following chapters. It examines and analyses first the specific innovational challenges that teams encountered during development of mobile Internet services. The data showed that the innovation processes involved a division of labour between different firms and industries. Division of labour, in turn, implied that organisational problems were at the heart of the innovational challenges. These observations raise the question of which organisational forms could be the most suitable for managing the observed challenges. The final section of Chapter 3 gives provisional answers to this question by developing a basic (or emerging) theory that predicts which alternative ways of organising the innovation processes might be superior.

Starting from the insights of the theoretical reflections, Chapter 4 compares the organisation of the different innovator teams and explains the emergence of the observed differences. The chapter closes with an analysis of the structural strengths and weaknesses of the different teams. The aim of the comparative analysis is to give provisional answers to the question of why differences in team organisation matter for team behaviour and team performance. Based on the insights of this analysis, it is hypothesised that different teams achieved a better or worse fit between their behaviour

and the innovational challenges because of differences in structural strengths and weaknesses These provisional hypotheses additionally provide a more refined guidance for the directed inquiry that follows.

Directed by the emerging theory developed in Chapter 3 and refined in 4.3, Chapter 5 examines and analyses team performance and team behaviours. The Main goal of the chapter is to empirically validate whether the behaviour of the teams followed their structure as hypothesised in Chapter 4 or if their behaviour is rather explained by non-structural reasons.

Chapter 6 pulls the strands of the previous chapters together and conclusively explains the causal links between team structure, team behaviours and team performance. It also discusses the preconditions for different team structures to emerge. Chapter 7 concludes this thesis by discussing the implications and limitations of its findings.

2. Innovation in Network Industries: A General Introduction and Analytical Framework

The following chapter will provide an overview of some of the more pertinent work on the management of innovation in network industries. The intention here is to establish a basic understanding of the industry-specific nature of innovations and their challenges. By addressing the following questions it will also help to identify variables of interests that are related to the building blocks of the analytical framework (see Figure 1): What are the specific characteristics of network industries and how do these relate joint innovation projects? What kind of innovation types can be expected in network industries and what kind of innovational challenges do these types entail? What approaches exist to manage innovational challenges and how can innovative performance be measured? As ALTHEIDE (1996: 26) put it: "We want to ask the rights questions—that is, those that are conceptually cogent". This chapter helps to find the 'right' questions and thus provides guidance through the process of data collection (see EISENHARDT 1989: 536; YIN 2003a: 3).

The chapter is structured as follows: The next section examines the specific characteristics of network industries and how these relate to the nature of the innovations to be jointly achieved. The second section analyses in greater detail the process of developing technical systems and putting them to market attempting to extract points of interest concerning innovational challenge and team behaviours. The third chapter establishes some general measures for evaluating innovative performance.

2.1 Innovation Management and the Peculiarities of Network Industries

Network industries include the telephone, email, Internet, computer hard- and software, video game and also the mobile telecommunications industries. This section examines the specific characteristics of these industries and their implications for innovation management.

The first subsection provides a brief overview of the characteristics of network industries. One distinct feature is the modular organisation of the supply side. Modularity of the supply side, in turn, spurs on certain kinds of innovations but decelerates others. The second sub-section therefore reviews in greater detail the recent debate on technical progress within modular industries. The last sub-section discusses then different kinds of innovations and how these relate to modular industries.

2.1.1 Characteristics of Network Markets

One of the main characteristics of network industries relates to the fact that the products or services supplied by the industry constitute systems composed out of physically separated, but mutually dependent components (SHY 2001: 2; ZERDICK et al. 2001: 180). A personal computer, for example, can be purchased independently from operating systems software, but will not function without the latter, just as mobile phones cannot establish a connection if the mobile telecommunications network is down. The

possibility of separating and recombining the components of such product systems has also been termed modularity (SCHILLING 2000: 312).

Another distinct product feature of most network markets is that the product systems incorporate a general-purpose technology. The general-purpose technology itself plays only the role of an enabling technology rather than offering final applications. Incentives to put the general-purpose technology to use are instead provided by other components (BRESNAHAN and TRATJENBERG 1995: 84). Electric power systems, for example, produce electricity, but a consumer could not make use of the electric current without electrical devices. Television is similarly just a technology for broadcasting moving images by using radio waves. It is the information and media content that makes television interesting and entertaining. The same phenomenon can be observed in the personal computer industry, as hard- and software are interdependent. This hardware-software paradigm—as KATZ and SHAPIRO (1985: 424) coined it—also applies to video games, DVD-players and many other products. The general-purpose technology is usually embodied in a major subsystem. BRESNAHAN and GREENSTEIN (1999: 4) therefore also refer to platforms.

The physical decomposition of the product systems, i.e. its modularisation, is accompanied by a corresponding decomposition of the supply side. Multiple firms highly focused on particular modules jointly contribute to the supply of the systems. Mobile phones can be purchased from different sources independently from the network provider—as well as alternative operating systems can be run on personal computer hardware. Yet, division of labour in the light of technical interdependency raises the question of how interoperability can be maintained. Without interoperability different modules could not be mixed-and-matched together and form a functioning system. In network industries suppliers of system components have agreed to design their products according to standardised interfaces and therefore conscious organisation of component supply is no longer necessary.[3] The multiple firms organise themselves governing their exchange transactions through arm's-lengths relationships (ZERDICK et al. 2001: 180).

The technical interdependence of the components, nevertheless, implies that consumers in network industries are shopping rather for complete systems than for individual modules (SHY 2001: 2). In other words, the demand for components is interdependent as well. As a computer has no use without an operating system, consequently demand for operating systems will increase the more computers are sold. On the other hand, if operating system software packages cannot be supplied in sufficient volumes then sales of computers will drop or at least slow down. Such demand interdependencies are also known as network or adoption externalities (SHY 2001: 5).

2.1.2 Modularity in Products, Industries and Innovations

The previous paragraphs highlighted the main characteristics of network industries that distinguish them from other industries in their daily operations. The following para-

[3] See WALDENBERGER (1999) on the importance of standards as prerequisite for the emergence of markets.