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EFFECTIVE DECISION MAKING IN THE
HIGH-TECH SERVICE INNOVATION
PROCESS

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EFFECTIVE DECISION MAKING IN THE HIGH-TECH SERVICE INNOVATION PROCESS

PROEFSCHRIFT

Ter verkrijging van de graad van doctor
aan de Universiteit Maastricht,
op gezag van de Rector Magnificus,
Prof. Dr. A.C. Nieuwenhuijzen Kruseman,
volgens het besluit van het College van Decanen,
in het openbaar te verdedigen
op 16 januari 2003 om 14.00 uur

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Acknowledgements

I have experienced conducting the four individual research projects underlying this dissertation, as well as the process of integrating them, like undertaking a number of exploratory journeys into a varied and very exciting territory. At the beginning of each journey, the terrain appeared highly unfamiliar, and my steps were uncertain. And apparently similar to what the project managers experienced, whom I interviewed in the case study reported in Chapter Three of this thesis, I often had the feeling that the further I proceeded, the more I succeeded in reducing the initial uncertainty, until I finally arrived at a stage where things started to fit together and to make sense. In spite of being prepared and equipped with basic roadmaps and survival tools, a compass and some protective clothing, during such trips the explorer inevitably encounters unexpected challenges and difficulties, and also inevitably hits upon a number of surprising viewpoints. The challenges are duly dealt with - and in a sense also soon forgotten - but some of the best views are captured and brought home. To me, at least, this report therefore has the additional function of a travel account. And although I realize that the true significance of things often resides in the eye of the beholder, through the publication of this dissertation I hope to share some of the views I encountered during my voyage with the reader.

I wish to thank everyone who has been involved in the preparation as

well as in the realization of this voyage. Special thanks go obviously to the supervisor of my PhD project Jos Lemmink. He offered me the opportunity to do what I had wanted to do for some time, and to realize an old dream. Jos also helped me substantially during the project by providing contacts with Dutchtone and AFSMI. Furthermore, he has put me on the right track many times with his helpful insights. Hans Ouwersloot, the co-supervisor of my project, deserves my respect and thanks for the time and effort he put in critically reading and commenting the various papers that were part of the project, as well as the finished dissertation. Many thanks are also for Annouk Lievens, who put great effort into familiarizing me with the necessary basics of case methodology and of research methodology in general.

My gratitude also goes to my colleagues and ex-colleagues of the Marketing Department of Maastricht University, who have always been prepared to provide help with whatever technical, methodological, or practical problem I encountered in this project. In particular, I would like to thank Veronica Liljander, Kyriakos Kyriakopoulos, Nadine Roijackers and Janjaap Semeijn who critically reviewed and commented several of the papers, and Sandra Streukens who was always prepared to have a look at the data and the methodology. Ad de Jong and Janjaap Semeijn have both served their duty as patient and very supportive roommates. I would also like to express my gratitude to Guy de Seveaux and Simone van Schaik at Dutchtone and Pim Bonsel at AFSMI, who enthusiastically facilitated parts of the research.

Last but not least, I owe a lot to the continued support of my friends and family, who played an often invisible, but nonetheless indispensable role in the background:

MANY THANKS!

Executive Summary

The present dissertation is based on four self contained, and independently conducted studies, sharing one common theme:

The identification of factors positively and negatively affecting the effectiveness of decision-making under uncertainty in the unique applied context of high-tech service innovation.

A multidisciplinary approach has been adopted, and in the four studies the issue of decision-making effectiveness was investigated from several different perspectives, making use of a variety of research methods. In the first study, academic literature on decision-making under uncertainty is reviewed. In this study, the question is addressed, how the use of different cognitive decision-making styles may affect decision-making effectiveness. Based on a review of the literature from various disciplines and research streams, propositions are formulated about the relationships between task conditions and relative use of information processing styles, as well as about various factors moderating the validity of results obtained by making use of different cognitive styles under various circumstances. A comprehensive model is constructed, summarizing these theoretical propositions. In this study, cognitive continuum theory is extended with an extra dimension: Four primary decision-making styles, based on the relative use of two fundamental information-processing modes, are distinguished, instead of the traditional three.

The second study is based on an extensive case research, which was conducted in the mobile telecommunication services industry. In this study the questions; 'What characterizes the task conditions of managers in charge of high-tech service innovation projects?', and 'Which factors serve as antecedents of effective decision-making under these conditions?' are addressed. The study provides detailed insight, on a behavioral level, in the roles of previous experience and information in the innovation process. A major result is the identification of the moderating role of decision-makers' insight in the interfaces between the new service and the organization, the new service and the customer, the new service and the technology, and finally between the new service and the regulatory environment. Furthermore, the antecedent role of a flexible and balanced use of multiple decision-making styles is discussed.

The third study is based on a decision-making experiment. In this study, the problems of information overload and escalation of managerial commitment are addressed. Traditionally, decision-making has been conceptualized as the choice of a course of action. We argue that decision-making leads to both a choice of a course of action on the one hand and the development of a decision-maker's commitment to that choice on the other. Both types of consequences of a decision appear equally important with respect to their influence on decision-making effectiveness. It is demonstrated in the study that different aspects of information have distinct effects on choice and commitment. Information that appears irrelevant to the decision problem, but which affects the morale of decision-makers, does affect the decision-maker's commitment to the decision equally well.

The fourth study is based on a global survey of managers involved in high-tech service innovation projects. In this study, the role information processes

play in creating inter-firm differences in innovation success is investigated. Effects of information gathering, diffusion and utilization are demonstrated in two distinct stages of the innovation process; the stage of the strategic go-no-go decision, and the operational stage of new service development. With respect to the initial go-no-go decision, the most important findings are the positive contributions of a long-term and entrepreneurial attitude, of the use of both internal and external information in the process and of the involvement of strategically knowledgeable decision-makers. In the operational phase of the innovation process, organizational intelligence gathering with respect to developments in technology and customer requirements was demonstrated to contribute positively to innovative success. Informal communication, an open organizational climate, which is favorable to innovation related information exchange, as well as regular knowledge updating by managers involved in the innovation process were also found to play an important role in this stage.

Together, the four studies provide rich insight in the major challenges decision-makers encounter in the high-tech service innovation process. Insight is also created into some of the factors that can be manipulated by firms in order to increase the effectiveness of their decision-making and improve the chances of success of high-tech service innovation projects.

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Chapter 1

Introduction

The purpose of this chapter is to introduce the focal theme of the dissertation to the reader. A rationale for the research as a whole is presented, and a general problem statement is formulated. The reader is then introduced to the respective research questions, theoretical perspectives, objectives, and intended contributions of the four self-contained studies that make up the research. Finally, the reader is provided with an outline of the remaining part of the dissertation.

This introductory chapter of the dissertation consists of three sections. In Section 1.1, the focal theme of the dissertation will be introduced. A rationale for the research is provided, and a problem statement is formulated for the dissertation as a whole. In Section 1.2, the purpose, research questions, and intended contributions of the separate chapters of the thesis are presented. The four self-contained studies are also positioned in the broader context of research in the management sciences. Finally, in Section 1.3, an outline of the remaining part of the dissertation is presented.

1.1 Effective Decision Making in High Tech Service Innovation

In this section the subject matter of the dissertation is presented: managerial decision-making in the high-tech service innovation process. The reader will be provided with a number of reasons why this topic deserves special attention. First, the phenomenon of *high-tech services* is introduced and it is explained why the importance of high-tech services in the global economy is still increasing. Furthermore, the role of *innovation* in the high-tech services industry is clarified. Subsequently, it is pointed out what makes innovation in the high-tech services industry very risky, and why it is necessary to *improve the performance of the high-tech service innovation process*. Finally, arguments are presented as to why *developing a better understanding of the factors affecting the effectiveness of managerial decision-making* in the innovation process can lead to the desired result.

1.1.1 High Tech Services

Over the past decennia, the world has witnessed what has been called the ICT revolution. A range of major achievements in information and communication technology (ICT) have paved the way for the development and commercialization of a wide range of really new technology based services (Lehmann 1997). These high-tech services can create substantial value for the providers as well as for the consumers of the services (Van den Ende and Wijnberg 2001). Oftentimes, these ICT-based services are replacing traditional, labor-intensive, services. This substitution can lead to a substantial cost reduction for the provider. A familiar example from the financial services sector, demonstrating the power of information and communication technology to substantially improve the productivity of services, is the substitution of bank counters with ATM's and online banking services. Other sectors of the services industry, such as insurances, the stock exchange, the travel industry, media, telecommunications, and IT-service providers are currently also tapping into the potential of ICT-based services. Apart from cost-savings, the use of modern information and communication technology also increases the quality and the value added of existing services. At the same time, numerous entirely new services are being developed and offered that could not have been imagined only recently, creating considerable entrepreneurial opportunities. As a consequence of these developments, the world of services is changing dramatically in many respects, for the companies that conceptualize, develop and commercialize these new ICT-based services, as well as for their customers (Meuter 1999).

1.1.2 Innovation in High Tech Services

Indeed, innovation is considered the lifeblood of the economy as a whole (Schumpeter 1934) and an important source of prosperity in society (Greenspan 1996). The introduction of new products and services has been shown to contribute in an important sense to the growth, competitiveness and profitability of firms (Suàrez and Utterback 1995; Tushman and Anderson 1996; Tushman and Anderson 1986). The regular introduction of really new or substantially improved ICT-based services – intended either as core services or as customer services supporting other products - has become vitally important for the creation of customer value and satisfaction.

However, although the ICT revolution has provided many important entrepreneurial opportunities to service firms, it also threatens the survival of companies in the sector. There is little doubt as to the fact that the speed of technological change and the globalization of the marketplace have severely intensified inter-firm competition in the high-tech service industry. As a result of increased price transparency, customers are now able to compare products and prices on a global scale. They have become much more demanding with respect to product or service specifications, perceived value and the convenience of delivery or fulfillment. Furthermore, the high speed of technological developments has substantially reduced the life cycle of high-tech products (Cooper 1996), and even very successful ICT-based services seem to become rapidly obsolete and must be improved or replaced on a regular basis. Innovations also spread much more rapidly and the creative destruction of innovation (Schumpeter 1934) will occur much faster in a world dominated by information technology. Major threats affecting the ICT-based service sector are thus rapidly changing customer requirements, intensified competition, turbulent marketplaces, and the high speed of technological de-

velopments and shortened life cycles of services. The fact that firms can neutralize these important threats by constantly improving existing services and effectively introducing successful new services, underlines the importance of innovation in the high-tech service industry as a major source of competitive advantage.

Notwithstanding the urgent need for new service success, many high-tech service innovations fail to live up to the expectations of both providers and consumers, in spite of huge investments in research and development. Too many services do not add the intended value to the customer, do not match customer requirements with respect to service quality and user-friendliness, or simply do not become commercial successes. At the same time, innovation in high-tech services generally requires considerable investments in the technological infrastructure, as well as extensive adaptations in the organizational structure of the firm (Tushman and O'Reilly III 1997). The uncertainty, dynamics and complexity of the high-tech service industry create major challenges for innovating firms and negatively affect the performance of the innovation process, in terms of the success rate (e.g. Cooper and Edgett 1996). The observation of high failure rates and high levels of investments leads to the conclusion that innovation in the high-tech service industry is very risky. If survival chances of firms, active in the high-tech service sector, are to be increased, a structural improvement of high-tech service innovation process performance could be a good starting point. Based upon the arguments presented above, we conclude that any research contributing to improvements in the success rate of high-tech service innovations must be considered of the greatest economic importance (Boulding et al. 1997).

1.1.3 Decision Making in the High Tech Service Innovation Process

Why is the failure rate in high-tech service innovation so high? The speed and unpredictability of technological developments, the increased complexity of the technologies in use, the globalization and turbulence of markets, as well as rapidly changing customer requirements and the resulting uncertainty about future states of the world are making high-tech service innovation an extremely complex matter (Edvardsson et al. 1995). Nonetheless, as we have argued, the new economy demands fast, continuous and highly effective innovation, in spite of the extreme complexity of the task, which in turn requires the development of sophisticated, appropriately adapted and very effective new service development (NSD) processes (Cooper 1996).

To date, research with the intention of developing a better understanding of high-tech service innovation and identifying new service success factors has mainly focused on factors external to the new service development process (Martin and Horne 1995). As a result, the internals of the high-tech service development process are relatively underexposed in academic research. In recent studies, effective information processing and communication during the new service development process have been put forward as important antecedents of service innovation success (Lievens and Moenaert 2000a; Lievens and Moenaert 2000c; Lievens et al. 1997). Managers transform information into action through their decision-making (March 1991) and the performance of organizational processes has been associated with the effectiveness of managerial decision-making (Galbraith 1973; Galbraith 1974; March 1999; Penrose 1959). Therefore, the present dissertation approaches the problem of high-tech service innovation success as a *decision-making performance* problem, and thus investigates the new service development process *from the*

inside. The focus will be on the identification of antecedents and moderators of *decision-making effectiveness* of managers in charge of the new service development process. The central problem statement of the dissertation thus reads:

- *How can the effectiveness of managerial decision-making under the conditions present during the high-tech service innovation process be increased?*

1.2 Perspective and Intended Contributions of the Various Parts of the Study

The problem statement of the dissertation will be addressed in four inter-related studies. In each of these studies, we approach the problem from a different theoretical perspective. The role of cognitive decision-making styles, antecedents of information utilization, and organizational information acquisition, and diffusion are studied with respect to their effect on the performance of the new service development process. In this section, the different perspectives will be introduced and clarified.

1.2.1 Study One

In existing behavioral literature on decision-making under uncertainty, associated with the discussion about the value of managerial use of intuitive cognition, the effectiveness of managerial decision-making has been related to the decision-making style used by the manager. The use of a decision-style that is better adapted to the cognitive requirements of the decision context is associated with more effective decision-making (Payne 1997). In

the first study in this dissertation, the general problem statement is therefore approached with a focus on the cognitive decision-making style and its relationship with the task conditions of the decision-maker. The high-tech service industry stands out with respect to the level as well as the sources of uncertainty in the task environment of the firm's key innovation decision-makers. In this conceptual study, the relative value of different cognitive styles for the reduction of uncertainty is therefore assessed, under various categories of decision-maker task conditions. The focus is on the identification of inherent differences in the effectiveness and scope of cognitive styles. The used methodology is an extensive review of the literature on decision-making under uncertainty, combined with findings about information processing styles from the field of cognitive psychology. The problem statement guiding the first study is:

- *What is the relationship between task conditions, the use of a particular cognitive style and the effectiveness of decision-making under circumstances prevailing during the high-tech service innovation process?*

The purpose of the study is the development of a comprehensive conceptual model, allowing decision-makers to evaluate different cognitive styles theoretically for what they are worth under the extreme conditions encountered during different stages of the high-tech service innovation process.

1.2.2 Study Two

After the introduction of a more organic organization structure, and the resulting far-reaching decentralization of decision-making authority in modern high-tech industries, the role of individual product managers in charge of innovation projects has become key to the performance of the innovation

process as a whole (Burns and Stalker 2001). In the second study, a case research perspective is adopted, which allows an in-depth investigation of major antecedents of high-tech new service development process performance at the level of individual project managers. The project manager has the formidable task of selecting and integrating relevant information from specialists in various disciplines, and deal with the inherent dynamics and complexity of the service innovation process. With the double purpose of developing in-depth insight in the task conditions of managers in the high-tech service innovation process, and to identify antecedents of effective decision-making, a case study of four telecommunications service innovations was conducted. The research questions addressed in this study are:

- *What do the task conditions of innovation project managers consist of, in the high-tech service industry?*
- *Which cognitive and organizational skills contribute to more effective decision-making of project managers?*
- *How can firms facilitate effective decision-making in the high-tech service innovation process?*

The purpose of the study is the development of a comprehensive model, integrating antecedents and moderators of effective decision-making in the new service development process.

1.2.3 Study Three

In organizational decision-making theory it has become clear that not only the *choice* of a preferred course of action plays an important role in determining decision-making effectiveness. The *strength of managerial commitment*

to that chosen course of action plays an equally important role (Staw 1997). In spite of the highly undesirable economic effects of so-called escalations of commitment in high-tech innovation projects, very little research has focused on the development of commitment during the decision-making process. Especially in decision-making under extreme uncertainty, and under dynamic and ambiguous conditions, occurring during the high-tech service innovation process, escalations of commitment seem to take place on a frequent basis (Drummond 1998; Ghosh 1995; Keil et al. 1995). Existing literature on bounded rationality has traditionally conceptualized decision-making as the *selection* or *choice* of a preferred course of action, in order to maximize or satisfice the decision-maker's utility. This focus on *choice* has caused the research strand to overlook the development of managerial *commitment* to the chosen course of action. In the third study a perspective is therefore adopted that is generally associated with the literature on bounded rationality and the study of bias in the rationality of decision-makers, but specifically investigating the effect of information on the development of initial commitment. A decision-making experiment is conducted, with the purpose of exploring the effects of information on choice and commitment. The research question guiding the study is:

- *What are the effects of information on managerial judgment and initial commitment to a decision, under conditions of uncertainty caused by information overload?*

The objective of the study is to make two theoretical contributions to the bounded rationality literature. First, the theory of bounded rationality is extended to include an important outcome of managerial decision-making, namely managerial commitment to a chosen course of action. Second, information overload is considered as a unique cause of specific bias in managerial

judgment.

1.2.4 Study Four

In previous research, it has been demonstrated that information processes and communication play an important role in determining innovative success (Lievens and Moenaert 2000b; Lievens et al. 1999b). With the objective of extending the literature about success factors in service innovation, in a fourth study organizational characteristics are identified, related to information acquisition, diffusion and use, that act as antecedents of effective managerial decision-making and innovative success. In an empirical study, data are collected about a large international sample of service innovations. The problem statement guiding the fourth study is:

- *Which factors affect, through their influence on organizational information processing and decision-making effectiveness, high-tech service innovation performance?*

The purpose of this study is to explore the antecedents of high-tech service innovation related decision-making effectiveness on both a strategic and an operational level and to integrate the findings in a comprehensive model.

1.3 Outline of the Dissertation

The fundamental purpose of this dissertation is to develop insight in factors affecting managerial decision-making effectiveness in the high-tech service innovation process. The central issues of the dissertation, effective decision-making under uncertainty and its antecedents, are approached from a number of different perspectives and with different methods. The remaining part of the dissertation consists of the following chapters:

Although much research has been devoted to the study of decision-making under uncertainty, a comprehensive model relating task conditions, cognitive decision styles and moderators of decision-making effectiveness is still lacking. In Chapter Two, the results of a conceptual study, investigating the effects of using various managerial decision-styles on decision-making effectiveness under conditions of great uncertainty, are presented.

The high-tech service innovation process has not been studied extensively from the inside. This is, however, the perspective that can teach us most about the antecedents of innovation success. In Chapter Three, the results of an extensive case study in the mobile telecommunications industry are presented. Based upon an analysis of four high-tech service innovation projects, a theoretical model is constructed with respect to antecedents of effective decision-making in high-tech service innovation.

Most research in the area of decision-making under uncertainty has conceptualized decision-making as a choice, based upon decision-maker's maximizing or satisficing of expected utility. But for the effectiveness with which the decision-maker manages a process, not only his choices are important. Managerial commitment to those choices appears equally important. In Chapter Four, the results of an experimental study, investigating the effect of information overload on managerial decision-making, are presented. Decision-making is conceptualized in this study as *choice and commitment*.

In Chapter Five, the results of an empirical study, investigating organizational antecedents of effective decision-making in high-tech service innovation, are presented. These factors are associated with the success of high-tech service innovation projects. Inter-firm variance in high-tech service innovation success is thus explained in terms of information processing related antecedents of successful innovative decision-making.

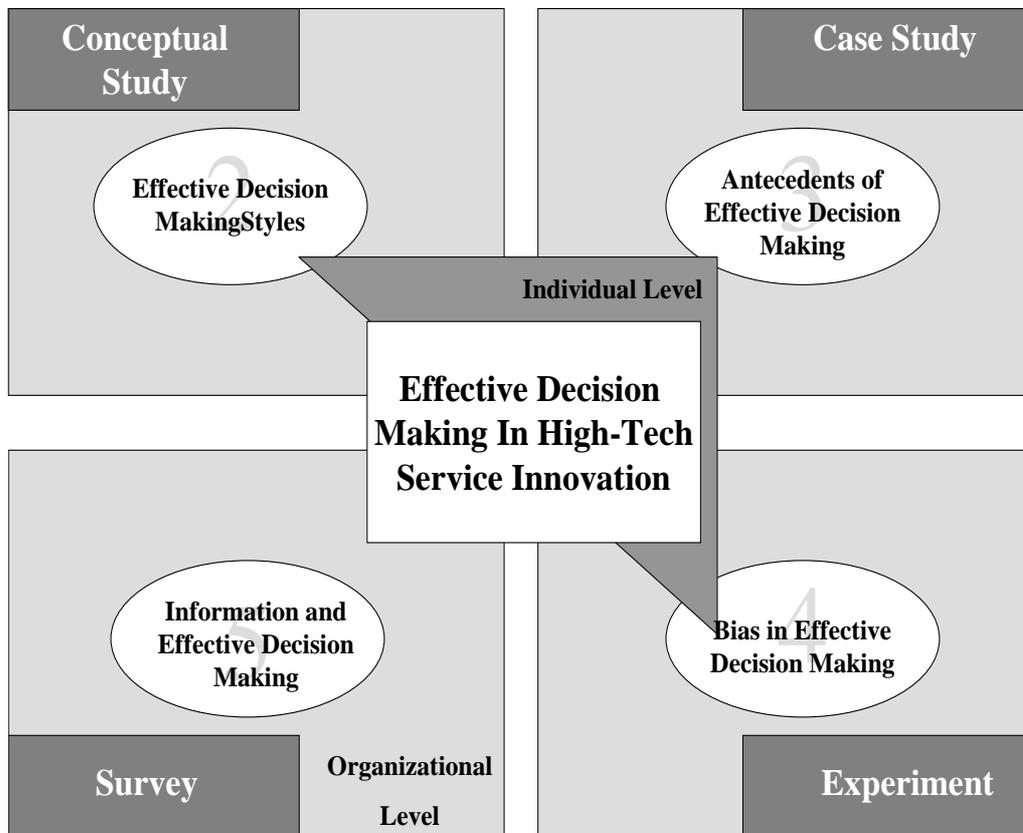


Figure 1.1: Overview of the Dissertation

In Chapter Six, the dissertation is concluded with a summary of the results, managerial implications and suggestions for further research. The approach taken in the dissertation is visualized in Figure 1.1.

Chapter 2

Effectiveness and Scope of Decision Making Styles

In this chapter, cognitive aspects of decision-making are considered against the background of high-tech service innovation. During the innovation process, crucial decisions are made under challenging conditions. Managers encounter significant time pressure, complexity, and a lack of information. Performance, conceptualized as decision-making effectiveness, is associated with the appropriate use of cognitive styles. Theories about decision-making under uncertainty, and the use of managerial judgment and intuition, are reviewed and integrated. Four basic cognitive styles are identified and evaluated for relative effectiveness under each of four elementary task conditions. Propositions are developed about the relationships between task conditions and the relative use of styles, and about moderators of style effectiveness. Contributions of the study are a conceptual clarification of the distinction between intuition, heuristics, and bounded rationality, and the assessment of the scope of various cognitive styles and moderators of their effectiveness.

Daß alle unsere Erkenntnis mit der Erfahrung anfangt, daran ist gar kein Zweifel. (Immanuel Kant, Kritik der Reinen Vernunft, p.27)

2.1 Introduction

As a result of a quick succession of substantial technological changes, and hypercompetition in the marketplace, the macro environment of firms in high-tech service sectors is currently characterized by great turbulence and uncertainty (D'Aveni 1995; D'Aveni 1994). In such turbulent environments, successful innovation is said to be key to firm survival (Lehmann 1997), since it reflects the organizational ability to cope productively with high levels of uncertainty and rapid change in the environment (Anderson and Tushman 2001; Hannan and Freeman 1989; Nelson and Winter 1982). The performance of organizational processes, such as new service development, is generally considered to be positively and strongly correlated to the effectiveness of related managerial decision-making (Galbraith 1973; Galbraith 1974; March 1999; Penrose 1959). In particular, the degree to which managers effectively make decisions in the innovation process will therefore have a major impact on the performance of the process and as a result on survival chances of high-tech service firms.

The task conditions of high-tech service innovation managers reflect the turbulence and uncertainty in the firm's macro-environment. Many decisions must be made under very difficult conditions, caused by considerable time pressure (Payne et al. 1990; Simon 1997), extensive problem complexity (Weick 2001), a lack of information, and resulting high levels of uncertainty. Still, decision-makers in charge of the innovation process are not allowed or supposed to simply throw dice (Bazerman 2001; Hammond 1996). They must

respond in an appropriate manner to what they know about the situation (Wagner and Sternberg 1986). In order to do so, they must make intelligent use of a combination of available cues and their experience on the one hand and their cognitive skills on the other (Hammond 1996; Simon 1997).

Previous studies seem to indicate that decision-makers principally deal with conditions of considerable uncertainty by adapting their cognitive style to the requirements of the circumstances (e.g. Agor 1986; Behling and Eckel 1991; Burke and Miller 1999; Harper 1988). A number of cognitive styles, employed by managers in order to make decisions effectively under various circumstances, have been identified (Payne 1982; Payne 1976; Simon 1997). With respect to an understanding of decision-making in the high-tech service innovation process, knowledge is substantially lacking in several areas. For example, little is known about the *scope* of each of the styles, i.e. the range of situations to which a style may validly be applied, or about the *effectiveness* of particular styles in reducing the uncertainty, under varying task conditions. Research is therefore urgently needed to investigate the following issue:

- *What is the relationship between task conditions, the use of a particular cognitive style and the effectiveness of decision-making under circumstances prevailing during the high-tech service innovation process?*

Four interrelated research questions have been formulated, in order to deal with this problem statement:

- RQ 1:** *Which fundamentally different decision-making styles can be distinguished and how are they related to underlying cognitive mechanisms?*
- RQ 2:** *Which task conditions prevail in the high-tech service innovation process, and how do these conditions affect*

the relative importance of the styles?

RQ 3: *Which factors moderate the validity of the use of cognitive mechanisms and the resulting effectiveness of each style?*

RQ 4: *How does time pressure affect the appropriateness of different styles?*

The remaining part of the chapter is structured as follows. First, a preliminary theoretical framework is developed for the study. By means of a review of relevant literature from different disciplines and fields, four fundamental decision-making styles are identified. Based upon an analysis of the cognitive processes underlying the four decision styles, propositions are formulated with respect to the suitability of the styles under various categories of task conditions. Subsequently, the question is addressed which factors moderate the validity of different styles, and determine the effect of time pressure. The resulting propositions are integrated in a comprehensive model and the chapter is concluded with managerial implications and a number of suggestions for further research.

2.2 Decision Making Effectiveness

Very high levels of uncertainty characterize each high-tech service innovation project at the outset. The skill with which managers succeed in rapidly and steadily reducing this initial uncertainty, through the collection of information on the one hand and effective decision-making on the other, determines the extent to which they obtain control over the performance of the process. Time pressure underlines decision-makers' need to deal fast and effectively with uncertainty. *Effective decision-making, uncertainty, decision-making*

styles and *time pressure* are core constructs in the following discussion. First, working definitions of these concepts and their interrelation will be proposed.

2.2.1 Effective Decision Making

Performance objectives of a new service development (NSD) process, such as the relationship between input (human and financial resources) and output (service features and quality) as well as desired development speed (Kessler and Chakrabarti 1996), are generally determined by matters external to the process. However, the performance of the innovation process – i.e. the extent to which the managers achieve or exceed these objectives, will – all other things being equal - be critically related to the quality of decision-making inside the process. We therefore define *effective* decision-making in such a way, that, all other things equal, *more effective decision-making* leads, in a probabilistic way, to *improved process performance*. In other words, in the following:

Decision-making effectiveness is conceptualized as the probability that a decision relating to a process contributes positively to the performance of that process.

2.2.2 Uncertainty

In the following, the concept of uncertainty is used in an exclusively cognitive sense, and not in an emotional sense. The decision-maker must have a reasonably accurate and complete mental representation of the innovation project and its interfaces with the world, in order to be able to make decisions effectively, and exert control over the performance of the innovation process. His mental image is obviously never entirely accurate or complete. Parts of

the picture are blurred, incomplete, missing, or simply wrong. From this perspective, any improvement in the accuracy or completeness of the mental image, or in other words the extent to which the decision-maker succeeds in *reducing the uncertainty* about the state of affairs, can be understood as a major antecedent of effective decision-making. However, it must be recognized, that uncertainty reduction can equally well be seen as a consequence of effective decision-making. For example, as a consequence of the decision to select a particular technology, the range of possible options for many other decisions in the process will be limited.

Based on the reasoning above, we conceptualize ‘uncertainty’ in a very general, cognitive and negative sense, as ‘ignorance’ or ‘not knowing’ (Lievens 1996). This definition underlines the fact that uncertainty is always and necessarily subjective and relative to the decision-maker: it is the *decision-maker* who does not know certain things that are useful for the decision under consideration. Therefore:

Uncertainty is a subjective cognitive state of a decision-maker, varying in level between two extremes. On the one extreme we find a total absence of useful knowledge and on the other the possession of a maximum amount of useful knowledge.

In reality, uncertainty is always limited. The residual uncertainty is the gap between available useful knowledge on the one side, and a ceiling of a maximal amount of useful knowledge on the other.¹ It can be represented as a knowledge ‘gap’ (Galbraith 1973; Galbraith 1974). Knowledge acquired be-

¹This does not imply that all useful knowledge can really be obtained. The cost, or effort needed in order to obtain certain useful knowledge can be very high, or even infinite. The decision-maker decides which price he or she is prepared to pay, and as a consequence the amount of risk he or she is prepared to take.

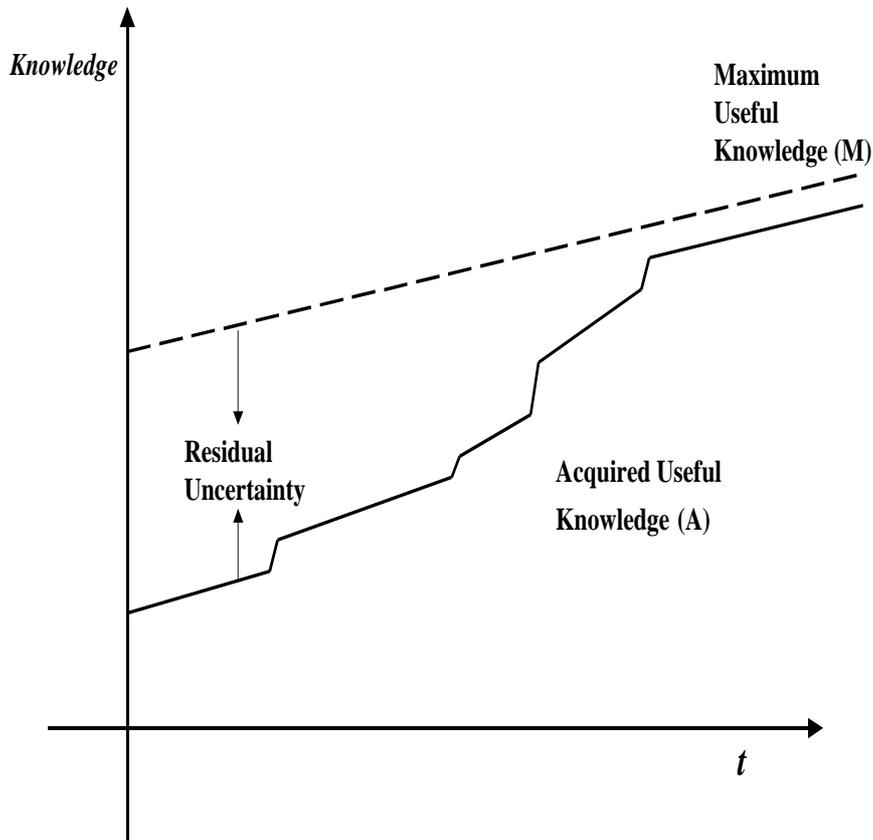


Figure 2.1: Residual Uncertainty as a Knowledge Gap

yond the ceiling is redundant. In Figure 2.1, the suggested conceptualization of the uncertainty of a decision-maker at a certain point in time, is visualized as a knowledge gap.

The irregular upward slope of the lower line in Figure 2.1 reflects reality to the extent that in practice the amount of acquired useful knowledge will increase over time; sometimes fast, sometimes slowly, as a result of endogenous efforts, such as explicit information gathering, increasing experience or as the result of key decisions. The determination of the precise shape of both lines

lies outside the scope of the present discussion. Exogenous causes, such as sudden changes in the technology, competitive action, or changes in industry structure etc. may increase or decrease both the maximum amount of useful knowledge and the relative amount of acquired knowledge, and therefore the degree of uncertainty with which the decision-maker will have to deal. The representation of the upper line as a knowledge ceiling may suffice for the current purposes.

2.2.3 Time Pressure

Decision-making in high-tech service innovation processes generally occurs under significant time pressure. The causes of time pressure are partially exogenous, and partially endogenous to the innovation process. First, hypercompetition causes great pressure on the firm to rapidly develop and introduce new services (D'Aveni 1995; D'Aveni 1994). Second, the speed of technological developments requires a fast innovation process. Time pressure has the overall effect that less information and knowledge can be acquired and processed, and less time can be spent on preparing and making decisions.

2.2.4 Decision Making Styles

Decision-makers' task conditions vary considerably over the innovation process. Uncertainty will take many shapes and will be caused by a variety of circumstances, e.g. changing customer requirements, or technological developments and decision-maker related factors such as a lack of decision-making experience. Both the task conditions causing the uncertainty, and the resulting level can vary. Near the end of the innovation process managers will most likely be dealing with relatively low levels of uncertainty. This implies that they will proceed faster and make bigger steps at the end, when

things become clearer, whereas at the beginning of the process the level of uncertainty is very high and things may move more slowly. Especially in a situation where great time pressure exists as a result of strong competitive pressure, the relative performance of the innovation process will critically depend on decision-making performance, i.e. the extent to which the involved manager makes effective decisions. Managers have always been searching for ways to deal effectively with elevated levels of uncertainty. For example, improving decision-making effectiveness could be achieved by employing a decision-making style that is optimally adapted to the circumstances. We conceptualize a decision-making style as:

The particular blend of cognitive activities used to transform given information (i.e. the information and knowledge acquired at a certain point in time) into a course of action.

In the field of cognitive psychology, a relationship has been posited between the extent to which individuals are able to adapt their cognitive style to the requirements of the actual task conditions and the extent to which they can successfully manage the challenges of that environment (Brunswik 1952; Hammond et al. 1987; Meehl 1954; Payne et al. 1990; Payne et al. 1988). In the following, the relationship between task conditions, cognitive style and decision-making effectiveness will be investigated.

2.3 The Scope of Decision Making Styles

In the following, literature with respect to human information processing systems and decision-making styles will be reviewed and integrated.

2.3.1 Two ‘Underlying Cognitive Systems’

Several managerial decision-making styles have been distinguished in the literature (Sauter 1999). Based upon reflections on Barnard’s distinction between logical and non-logical decision processes (Barnard 1938), Herbert Simon first distinguished two formally different decision-making techniques, an analytical and an intuitive style (Simon 1997; Simon 1987; Simon 1957). He related the first to the use of information and explicit reasoning, and the latter to the use of expertise and experience.

Western epistemology, the theory of knowledge, has almost exclusively focused on explicit, rational cognition, inspired by Aristotle’s works on logic, and culminating in Descartes’ glorification of human reason and rational science. True knowledge was conceptualized as a symbolical representation of an objectively – or at least intersubjectively – knowable reality. As a result, for centuries intuitive cognition – generally considered a more obscure, primitive², subjective or even private form of intelligence, could not compete with the objectively valid and universally reproducible truths of rational cognition. In the twentieth century, however, and largely as a result of the work of Egon Brunswik and Paul Meehl in cognitive psychology (Brunswik 1952; Meehl 1954), Herbert Simon in management theory (Simon 1997; Simon 1987) and Kenneth Hammond (Hammond and Bremer 1973; Hammond et al. 1987) in the social sciences, the phenomenon of intuitive intelligence has regained serious academic and practical interest (Agor 1984; Isaack 1978; Taggart and Robey 1981). Intuition was no longer universally seen as simply an inferior and more primitive form of cognition, but has actually been endowed with the potential of improving on rational cognition, in terms of decision-making effectiveness, under circumstances that impede rational cognition, such as

²Intuition has also been viewed as a ‘divine form of knowing’.

for instance in strategic decision-making (Burke and Miller 1999; Eisenhardt and Tabrizi 1995; Khatri and Ng 2000).

In psychology, the observation of two categorically different forms of cognitive activities has led scientists to posit the co-existence of two separate, but interactive, information-processing systems in the human brain, a rational and an experiential system (Denes-Raj and Epstein 1994; Epstein 1998; Epstein 1994; Epstein et al. 1992). The two complementary systems appear to be used in parallel, whereas the relative extent to which each system is used could be said to reflect the cognitive style (Epstein 1998). The individual preference for using one system over another has been viewed and subsequently investigated as a personality trait (Briggs-Myers and McCaulley 1985; Jung 1971). Some indications were found that the two cognitive systems are actually located in physically different parts of the human brain (Bechara et al. 1997), albeit not in the traditionally suggested left and right hemispheres (Simon 1987). The rational or analytical information processing system has been associated with articulate, symbolic, and explicit cause-and-effect reasoning. The experiential system has been associated with tacit, implicit, synthetic and, more recently, with associationist (connectionist) cognitive activities. The idea that human cognition is partially based on associationist or connectionist processes gained in popularity after the discovery of the workings of neurons and neural networks (Churchland 1995; Dutta 1993). Characteristics of the two cognitive systems are contrasted in Table 2.1.

The observation that in the actual practice of decision-making hybrid styles - combinations of rational and intuitive processing - are used by managers, has led to the development of a cognitive continuum theory (Hammond

Feature	Experiential System	Rational System
Perspective	Holistic	Analytic
Control	Automatic, Effortless	Intentional, Effortful
Orientation	Affective: Pleasure-Pain Oriented (What Feels Good)	Logical: Reason Oriented (What is Sensible)
Structure of Knowledge	Associationist Connections	Logical Connections
Effect on Behavior	Behavior Mediated by “vibes” from Past Events	Behavior Mediated by Conscious Appraisal of Events
Form	Encodes Reality in Concrete Images, Metaphors and Narratives: Subjective	Objective Representation of Reality in Abstract Symbols: Words and Numbers
Productivity	More Rapid Processing: Oriented toward Immediate Action	Slower Processing: Oriented toward Delayed Action
Adaptivity	Slower and More Resistant to Change: Changes with Repetitive/Intense Experience	Changes More Rapidly and Easily: Changes with Strength of Argument
Detail	More Crudely Differentiated: Broad Generalization Gradient, Stereotypical Thinking	More Highly Differentiated
Coherence of Output	More Crudely Integrated: Dissociative, Emotional Complexes, Context-Specific Processing	More Highly Integrated: Context-General Principles
Control	Experienced Passively and Pre-conscious: we are Seized by Emotion	Experienced Actively and Consciously: we are in Control of our Thoughts
Validity	Self-Evidently Valid: “Experiencing is Believing”	Requires Justification via Logic and Empirical Evidence

Table 2.1: Two Cognitive Systems. Ad. from: Teglas and Epstein (1998)



Figure 2.2: The Cognitive Continuum. Adapted from: Shanteau (1992)

and Bremer 1973), contending that decision-making styles can be positioned on a continuous scale with at one extreme entirely rational cognition, and at the other extreme purely intuitive cognition. Between the two extremes, different degrees of semi-rational cognition can be located (Hammond 2000). In Figure 2.2, we visually represent the cognitive continuum as proposed by Shanteau (1992).

However, the representation of the cognitive continuum on a single line seems to imply that a decrease in the intensity of rational processing always coincides with an increase in intuitive processing and vice versa. The one-dimensional scale does not allow for independent variation in the relative use of the two information systems and the intensity or effort with which each of them is employed. When we take the existence of two *independent* information-processing systems seriously, we must permit independent variation in the relative use of each system and in the ‘intensity of use’. This observation is graphically represented in Figure 2.3, as a matrix, with four quadrants.

Based upon deduction, and supported by the observation of practicing decision-makers, we propose to distinguish four basic decision-making styles,

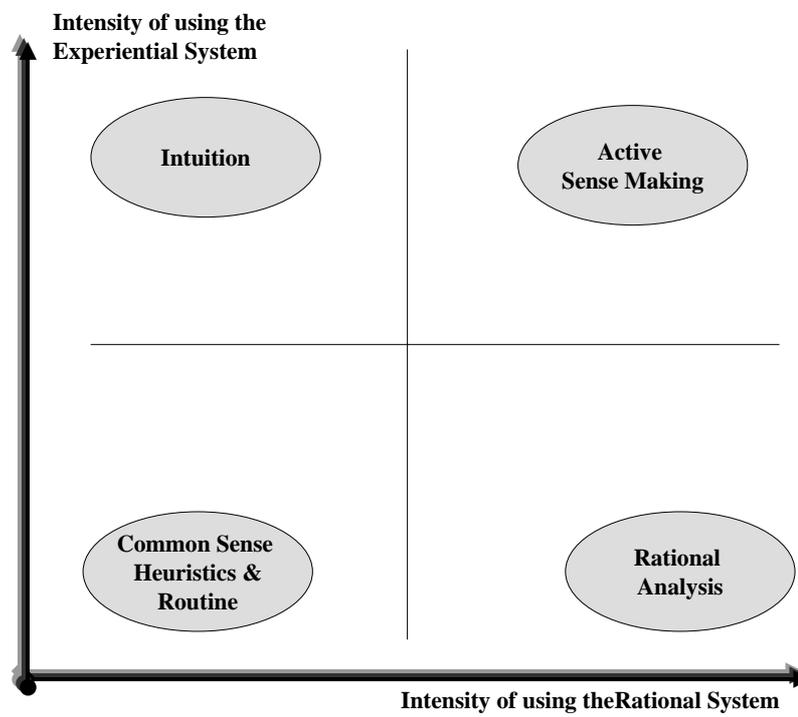


Figure 2.3: The Cognitive Style Matrix

represented by the four quadrants of the cognitive style matrix. First, a largely analytical style is distinguished. Rational analysis is characterized by an almost exclusive and intensive use of the rational system. Second, a principally intuitive style is distinguished, characterized by the almost exclusive and 'intensive' use of the experiential information processing system. Third, a style characterized by the combined use of relatively limited analytical thinking and experiential cognition of a limited scope is identified, which can be recognized in common sense, and also in heuristic or routine decision-making. This style seems to be best characterized by the term 'habit frozen into memory'. Finally, a fourth style is characterized by a combination or integration of high-intensity rational thinking and high-intensity experiential cognition. This style is preliminarily denoted with the term *active sense making*. The reason why will become clear further on. This style is characterized by a maximum use of a combination of both information-processing systems. Decision-makers thus have four basic decision styles at their disposition, based on the relative use of two fundamentally different cognitive information-processing systems. This answers the first research question.

2.3.2 Decision Making Styles and Task Conditions

So far, in studies of management decision-making the relative use of cognitive mechanisms in a decision-style has been said to reflect the requirements of the specific problem or task conditions to which a decision-maker is exposed. It has also been proposed that an optimal match exists between requirements and decision style (Payne 1997; Payne et al. 1990; Shapiro and Spence 1997; Spence and Brucks 1997).

Before addressing the question with respect to the relative effectiveness of the different styles, in terms of their ability to reduce uncertainty under

specific circumstances, first a better understanding must be developed of *how* information is processed when using different styles, and *which type of* information is processed. With respect to the nature of the process, it is often said that managers transform information or knowledge into action through their decisions (March 1991). It seems very useful indeed, to conceptualize the core cognitive activity involved in the decision-making process as a ‘transformation process’ of a ‘cognitive input’ into a ‘cognitive output’, which drives subsequent actions. Since it is our intention to determine the relationship between task conditions and the relative use of the respective cognitive systems, we first discuss existing knowledge with respect to the nature of intuitive and rational cognitive *processes*, and of the respective *output*. With the purpose of identifying factors moderating the validity of using various cognitive mechanisms, thereafter the nature of the *input* of both processes is discussed.

2.3.3 Information Processing Mechanisms

In the following, two fundamental information-processing systems are compared and discussed, with respect to their input, output and the nature of the transformation process. A special effort is made, not to confuse intuition with internalized analysis and systems of decision *rules* (Noorderhaven 1995), which would confound it with memorized rationally obtained knowledge, but to view it as a different form of cognition altogether, with different forms of input, storage and output.

2.3.3.1 Rational or Analytical Information Processing

The rational process has been used as a preferred example for most epistemological theories and has thus been studied extensively and described in

innumerable places. Moreover, since Kant made a distinction between the logical and perceptual dimensions of human knowledge, much attention has been paid to the logical structure of rational knowledge (Kant 1787). Here, we will therefore focus on those features that distinguish rational cognition most clearly from intuition. Rational thinking, or reasoning, is generally thought of as an explicit and sequential process that can be controlled and reproduced by the thinker and by any other person accepting the same rules of logic. The development of rational knowledge is deductive and analytic. The decision-maker follows a series of predetermined and communicable steps that transform given external or internal (Kahneman and Tversky 1982) information according to these rules of logic. Reasoning is thus seen as the processing of selected cognitive content, using the logic of causality: an intentional, constructive, rule-based and conscious activity. The building blocks of analytical or rational knowledge are pieces of information or judgments. In other words, rational thinking provides the manager with high cognitive control and high awareness, but is typically slow and can require intense structuring efforts from the decision-maker, depending on the complexity of the problem to be solved. Rational decision-making occurs in steps and allows the decision-maker to break up the problem, and if necessary, to distribute the parts over several experts. The effects of emotions, which are typically the result of individual experience, can be filtered out or neutralized in rational thinking, which makes the process more objective. Rational processing can be controlled in terms of its ‘intensity’. The decision-maker can determine *into how much detail he will go*.

2.3.3.2 Output of the Rational or Analytical Process

Uncertainty is reduced by the reorganization of existing knowledge, the integration of extra (internal or external) information or a combination, and based upon deduction. Rational output again takes the form of judgments or knowledge that can be analyzed into logical components and it has a high degree of internal validity. The meaning of rational judgment is or can be communicated, shared and justified with the same arguments used to arrive at the output. The decision-maker can determine the degree of detail. Rational output is always partial, necessarily incomplete. External validity of rational output must and can only be obtained through empirical testing.

2.3.3.3 Intuitive or Experiential Information Processing

It has been observed by many decision-makers that intuitive cognition, contrary to rational activity, produces solutions in their entirety and instantaneously (Bowers et al. 1990). A complete solution *emerges* as it were in the mind of the individual decision-maker. The person experiencing intuition suddenly *sees* how something could be done (Parikh et al. 1994; Vaughan 1990). In general, intuitive decision-makers have genuine problems articulating their preference of one alternative solution over another (Morris 1967), or how they arrived at that preference (Khatri and Ng 2000; Shapiro and Spence 1997; Simon 1997; Vaughan 1990). They also cannot exert cognitive control over the intuitive process, or break up the decision problem in parts. At the same time, no control can be exerted over the ‘intensity’ or comprehensiveness of the process. The intuitive process occurs non- or sub-consciously (Bastick 1982; Rowan 1989), and is *provoked* rather than used. Possibly as a result of this, it appears to be fast and not to require much effort (Bowers et al. 1990; Burke and Miller 1999; Hammond et al. 1987; Shirley

	Intuition	Analysis
Cognitive Control	Low	High
Rate of Data Processing	Rapid	Slow
Conscious Awareness	Low	High
Organizing Principle	Weighted Average	Task Specific
Errors	Normally Distributed	Few, but Large
Confidence in answer	High	Low
Confidence in method	Low	High

Table 2.2: Contrasting Processes. Source: Hammond et al. (1987)

and Langan-Fox 1996). When confronted with a problem, individuals often almost instantaneously have a feeling of what could be the right solution. Intuition is therefore often compared to perceptual functions such as ‘seeing’ or ‘recognizing’ a truth. Another important observation is that intuitive cognition is inductive (Agor 1984; Westcott 1968). Furthermore, it integrates or connects distributed knowledge, or experience originating from different domains of reality (Kuo 1998) and from different internal or external sensory organs (Weick 1985). It is therefore also called ‘behavioral’ (McCall Jr. and Kaplan 1990). The intuitive process is contrasted with rational cognition in Table 2.2.

2.3.3.4 Output of the Intuitive or Experiential Process

Experiences acquired in different domains of reality, in different ways and even via different senses (Weick 1985) can get connected or associated into intuitive knowledge (Agor 1986; Harper 1988; Kuo 1998). The generation of intuitive knowledge appears to be passive, and the actor is not consciously

involved in producing the knowledge. Most authors therefore stress that output from the intuitive system is self-evident (Epstein 1998; Shirley and Langan-Fox 1996; Vaughan 1990). Intuitive decision-makers simply ‘know’ the outcome and at the same time intuitive cognition inspires great confidence to the person experiencing the intuition (Bowers et al. 1990; Hammond et al. 1987; Shapiro and Spence 1997; Simon 1987). However, intuitive knowledge seems to be the result of a highly individual process, both in terms of inputs and of processing (or associating), and it is therefore difficult to justify and validate intuitive insights publicly, in an objective or even intersubjective sense (Molloy and Schwenk 1995). As a result, it is generally not possible to demonstrate the validity of intuitive knowledge in a similar way as the validity of rational knowledge can be demonstrated. Based upon the characteristics of the intuitive cognitive process a number of possible functions for intuitive cognition have been established. These functions are listed in Table 2.3.

2.3.3.5 Hybrid Style One: Common Sense Based Decision Making

With the term common sense we refer to the use of what has often been called ‘quick and dirty’ cognition. Common sense is characterized by a very high degree of efficiency, under most common circumstances. It is therefore applied in cases of relatively limited complexity and substance, and in cases where little in-depth justification is required. Heuristics, cognitive shortcuts, and routine decision-making are all related forms of common sense. Common sense seems to work best in situations that are characterized by a relatively high degree of regularity. Decision-makers use new information very selectively and rely on the validity of previous experience, with relatively little effort. The validity of judgments based on common sense is always indirect

Function	Explanation	Feature
Intuitive Discovery	Goes beyond simply providing answer to certain problem but is an insight into the real nature of the dilemma. It is likely to suddenly occur when the mind is actually occupied with something other than the problem to which the intuition is related.	Inductivity
Creative Intuition	Generates new ideas and involves alternatives and possibilities rather than facts and provable information.	Creativity, Non-linearity
Intuitive Evaluation	Leads to a feeling to prefer one alternative over the other and leads to a feeling of certitude that tentative conclusions are correct.	Integration of Affect
Operative Intuition	Influences and prompts individuals' actions without entering consciousness and gives a particular direction of action that is unexplainable.	Tacit Knowledge, Experience
Intuitive Prediction	Deals with the unknown, under which circumstances rational analysis is ineffective.	Synthesis, Tacitness
Intuitive Illumination	Transcends the other five functions of intuition and is associated with a higher form of knowing and resembles the more spiritual side of intuition.	Holistic Input

Table 2.3: Functions of Intuition. Adapted from Goldberg (1983; 1990)

and often based upon textbook knowledge, or external authority.

2.3.3.6 Hybrid Style Two: Active Sense Making

Some decision-makers can combine intense rational analysis with a great openness to intuitive insights. In what we have called active sense making, the decision-maker puts much effort into either reconciling his private or subjective intuitive insights with what is objectively known, or indeed into externalizing private knowledge. Therefore it seems that this mode can be genuinely synthetic or creative in nature: It has the potential of producing really new insights, a power that has traditionally - and seemingly erroneously - been attributed to intuition alone (Bowers et al. 1990). It seems, therefore, that only active sense making, precisely in its combination of logical analysis and intuitive insights, is authentically creative (Goldberg 1983; Kuhn 1996; Prietula and Simon 1989), even visionary (Agor 1986). This decision style seems to be suitable for very challenging conditions that require limited justification of separate steps, and much creativity, but where the decision-maker is held accountable for the process as a whole rather than for individual decisions or motivations³.

2.3.4 High Tech Service Innovation Task Conditions

Having distinguished four basic decision-making styles, four categories of task conditions are now discussed, potentially affecting decision-maker uncertainty. The following categories have been identified in managerial decision-making literature: the availability of information, problem complexity (Weick 1990), problem structuredness (Mintzberg et al. 1976), and the extent to which solving a problem requires the use of practical skills or tacit knowledge

³Scientific research comes to mind as an excellent example of such a human activity.

from the decision-maker (Wagner 1987; Wagner and Sternberg 1986; Wagner and Sternberg 1987). Theoretical propositions will be formulated with respect to the inherent appropriateness of the underlying cognitive styles for dealing with these conditions.

2.3.4.1 The Availability of Information and Data

First, task conditions of decision-makers vary in terms of the availability of high-quality data and information. Since strictly rational decision-making requires accurate and well structured information (Schoemaker 1982), the extent to which uncertainty reduction through rational analysis can be achieved will vary with the relative availability and quality of information. Newly acquired information can immediately be integrated with the existing explicit knowledge of the decision-maker and we expect that the availability of more information will thus lead to more effective rational processing:

Proposition 2.1 *There will be a positive relationship between the relative availability of high-quality information to the decision-maker and the extent to which uncertainty can be effectively reduced by using rational analysis.*

Task conditions characterized by a lack of complete, accurate and timely (high-quality) information (Harper 1988), seem to provoke a shift towards the use of intuitive cognition. The argument is, that where there is not much to process rationally, past experience could work as a substitute for explicit information, arguably the only substitute we have. Furthermore, the process of updating a decision-maker's intuitive knowledge occurs relatively slowly and new information will presumably not immediately add much to the reservoir of intuitive knowledge. As a consequence we expect:

Proposition 2.2 *There will be a negative relationship between the relative availability of high-quality information to the decision-maker and the extent to which uncertainty reduction can be achieved by using intuitive knowledge.*

2.3.4.2 Structuredness of the Decision Context

Second, decision conditions vary with respect to the so-called structuredness of the decision context (Mintzberg et al. 1976). Rational processing requires a well-structured decision problem: When the problem is clear to decision-makers, they can make rational calculations. We thus expect:

Proposition 2.3 *There will be a positive relationship between the relative structuredness of the decision context and the extent to which uncertainty can be reduced by using rational analysis.*

In many cases, for example in strategic decision-making, problems are ill structured. Ill structured problems are characterized by a high degree of uncertainty about the actual situation, about the desired situation, or about the way to get there, or a combination. Since rational analysis is unable to deal with ill-structured problems, and intuition seems to deal with the context in a more holistic way, not requiring a great degree of problem structuredness, we expect:

Proposition 2.4 *There will be a positive relationship between the relative ill structuredness of the decision problem and the extent to which uncertainty reduction can be achieved by using intuitive cognition.*

2.3.4.3 Complexity of the Decision Problem

Task conditions also vary with respect to the complexity of the decision context and the problems that are to be dealt with by the manager. Problem

complexity could be abstractly described by the *number of cues* or issues that play a role in a decision problem (Hammond et al. 1987). On the one hand, rational decision-makers have problems with considerable complexity. On the other hand, high levels of problem complexity require much processing effort from the decision-maker, a scarce resource under conditions of time pressure. We therefore expect:

Proposition 2.5 *There will be a negative relationship between the relative complexity of the decision problem and the extent to which uncertainty can be reduced by using rational analysis.*

Expertise has been characterized as the ability to reduce complexity (Blattberg and Hoch 1990; Simon 1987). Therefore the intuitive process, making use of expertise, seems more effective than rational processing in task environments characterized by high levels of complexity. We expect:

Proposition 2.6 *There will be a positive relationship between the relative complexity of the decision problem and the extent to which uncertainty can be reduced by using intuition.*

2.3.4.4 Role of Tacit Knowledge

Decision conditions differ in terms of the extent to which tacit knowledge plays a role in the decision context (Polanyi 1969; Polanyi 1962; Polanyi 1966). For example, in the case of new service development, managers build up a feeling for customer requirements over time. The skill to take customer requirements into account when developing a new service is largely tacit. The effectiveness of decision-making can thus decrease when existing tacit knowledge is ignored. Also, decision-makers access accumulated tacit, or non-articulate knowledge through their intuition. We thus expect:

Proposition 2.7 *There will be a positive relationship between the relative importance of tacit knowledge to the solution of a decision problem and the extent to which uncertainty can be reduced by making use of intuitive knowledge.*

As a consequence of its nature, tacit knowledge cannot be easily or rapidly articulated and will therefore be largely neglected in rational analysis. We expect:

Proposition 2.8 *There will be a negative relationship between the relative importance of tacit knowledge to the solution of a decision problem and the uncertainty reduction that can be achieved by exclusively using rational analysis.*

We visually represent the relationship between the nature of the task conditions and the likelihood that a cognitive style will help in achieving a reduction of the uncertainty in Figure 2.4. In this figure we relate the four identified dimensions of task conditions, i.e. availability of data or information, complexity, problem structuredness and articulation of the problem, and the effectiveness of the two fundamental cognitive processes. We have argued that a greater use of intuitive cognition will lead to greater uncertainty reduction in cases where the decision-maker is confronted with limited availability of information, ill-structured problem contexts, situations where tacit knowledge plays an important role and high levels of complexity. The use of rational analysis will generally be more effective in situations where the opposite is the case.

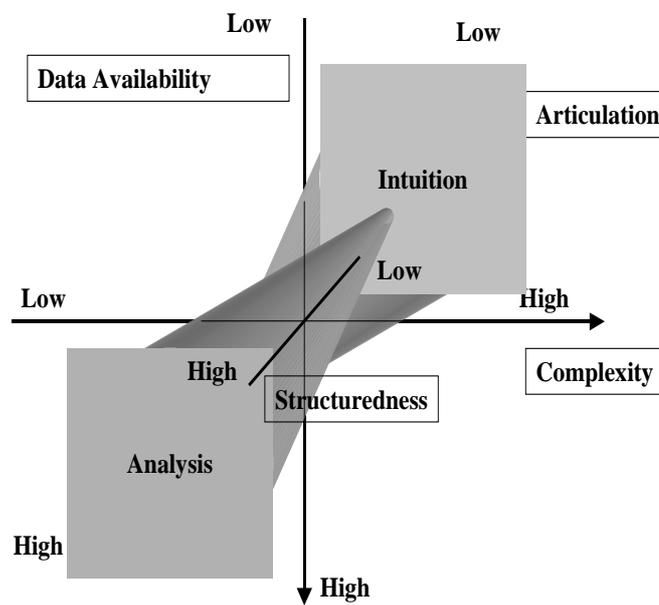


Figure 2.4: Task Conditions and Decision Style. Adapted from Shapiro and Spence (1997).

2.3.5 Factors Moderating the Effectiveness of Decision Making Styles

Adjustment of the decision style to the task conditions serves the primary purpose to reduce uncertainty in as sound and efficient a way as possible, under given circumstances, in order to make decisions more effectively. Having established which task conditions call for which cognitive style, we must now address the question which factors moderate the effectiveness of each of the two underlying cognitive systems, in validly reducing uncertainty. We will infer differences in scope, and corresponding limitations with respect to the validity of the two systems from the differences in the nature of the respective input.

2.3.5.1 Scope of Intuitive Cognition

The intuitive process appears to differ substantially from rational analysis in terms of the form of its input. We therefore first investigate if and how the format of the cognitive input can possibly moderate the validity of each of the styles. Whereof does the input of the intuitive process consist? An important aspect of intuitive cognition is that, whatever the origin of the knowledge, at the moment the intuitive insight occurs to the decision-maker, its input is sourced internally rather than externally. With respect to the origin of this knowledge, intuitive insight is often said to reflect individual expertise (Kuo 1998; Simon 1997) and to be based on individual experiences (Weick 1985). We therefore expect:

Proposition 2.9 *The extent to which a decision-maker will be able to reduce uncertainty effectively by making use of intuitive cognition will be moderated by the presence of valid individual experience or expertise in the mind of the*

decision-maker.

What can be considered valid experiential knowledge or expertise? Since the intuitive decision-maker relies on past experiences and tacit learning, the experientially acquired knowledge will be as domain-specific or non-specific (Kuo 1998; Simon 1987) and as reliable as the experiences of the individual decision-maker (Isenberg 1984). Therefore:

Proposition 2.10 *There will be a positive relationship between the extent to which the area of expertise, or the domain within which the decision-maker acquired experience, match the decision-problem, and the validity of experientially gathered knowledge.*

An important input is said to consist of implicit or tacit knowledge, or skills (Polanyi 1969), resulting from extensive experience (Agor 1986; Brockmann and Simmonds 1997; Isenberg 1984; Perkins and Rao 1990; Rowan 1989; Seebo 1993; Simon 1997; Wagner and Sternberg 1987). Tacit knowledge is said to be stored in the form of condensed associative patterns in long-term memory. As a result of the way it is built up and stored in memory, intuition is stable and not easily disrupted. Updating of tacit memory, or the input to the intuitive process, does not seem to occur directly, but rather through repeated experiences of similar, but structurally changing patterns. As a result, the validity of experientially gathered knowledge will be negatively related to the speed of change in the area where the expertise is acquired. If the speed of change is considerable, the experientially gathered knowledge may rapidly become outdated. We thus propose:

Proposition 2.11 *There will be an inverse relationship between the amount of turbulence in a problem domain and the validity of experientially gathered knowledge for decision-making in that area.*

Some authors have stressed that original (and consistent) emotional components of the experience may play an important role in the production of intuitive knowledge (Bastick 1982; Epstein 1998), since the associative processes underlying intuitive knowledge production are holistic. The repeated experience of any type of pattern-like perception, external or internal, can contribute to the production of intuitive knowledge. Since emotional involvement is generally considered to affect the objectivity of the decision-maker's judgment in a negative sense, we expect:

Proposition 2.12 *There will be an inverse relationship between the extent to which the decision-maker was emotionally involved while acquiring the experience, and the objective validity of the experientially gathered knowledge.*

2.3.5.2 Scope of Rational Cognition

Now the question needs to be addressed, which factors moderate the effectiveness of rational processing in achieving a reduction of uncertainty. In existing literature about bounded rationality in managerial decision-making, but also in epistemology, a number of moderators have been identified. The input of any rational or logic information processing system, be it human or electronic, must consist of articulate arguments with well-defined semantics (Wittgenstein 1953), built on informational components, each reflecting *facts* or *observations* (Wittgenstein 1922). The input of the rational system is formal and explicit, and expressed in a more or less symbolic language. The actor of the transformation process is required to select the inputs of the rational process. As a result the author of the process also has control over, and responsibility for, the (finite) input. Since the human information processing capacity is limited, the decision-maker can and must deliberately include certain information and exclude other (Simon 1997). The decision-

maker must also consciously assign weights or values to each fact, reflecting relative importance and meaning and is therefore prone to bias (Kahneman et al. 1982). What is actually selected as an input of rational processing is therefore dependent on the extent to which the decision-maker is able to make sense out of the situation (March 1997; Weick 1995). This brings in a dimension of bounded rationality. Values and weights are generally discussed and established in agreement with the dominant logic of the company (Bettis and Prahalad 1995; Grant 1988; Prahalad and Bettis 1986). Summarizing these arguments, we expect:

Proposition 2.13 *The effectiveness with which a decision-maker will be able to reduce the uncertainty by making use of rational analysis will be moderated by various bounds imposed on the rationality of the decision-maker.*

Since time pressure not only decreases the amount of time available to the decision-maker, which hinders the time-intensive rational decision process, but also reduces the amount of high quality information available to the decision-maker, we expect:

Proposition 2.14 *The extent to which a decision-maker will be able to reduce uncertainty by exclusively using rational analysis will be strongly moderated by time pressure.*

In Table 2.4 an overview is presented of all propositions developed in this chapter.

Table 2.4: Overview of the Propositions

Nr.	Proposition
P 2.1	There will be a positive relationship between the relative availability of high-quality information to the decision-maker and the extent to which uncertainty can be effectively reduced by using rational analysis.
P 2.2	There will be a negative relationship between the relative availability of high-quality information to the decision-maker and the extent to which uncertainty reduction can be achieved by using intuitive knowledge.
P 2.3	There will be a positive relationship between the relative structuredness of the decision context and the extent to which uncertainty can be reduced by using rational analysis.
P 2.4	There will be a positive relationship between the relative ill structuredness of the decision problem and the extent to which uncertainty reduction can be achieved by using intuitive cognition.
P 2.5	There will be a negative relationship between the relative complexity of the decision problem and the extent to which uncertainty can be reduced by using rational analysis.
P 2.6	There will be a positive relationship between the relative complexity of the decision problem and the extent to which uncertainty can be reduced by using intuition.
P 2.7	There will be a positive relationship between the relative importance of tacit knowledge to the solution of a decision problem and the extent to which uncertainty can be reduced by making use of intuitive knowledge.
P 2.8	There will be a negative relationship between the relative importance of tacit knowledge to the solution of a decision problem and the uncertainty reduction that can be achieved by exclusively using rational analysis.
P 2.9	The extent to which a decision-maker will be able to reduce uncertainty effectively by making use of intuitive cognition will be moderated by the presence of valid individual experience or expertise in the mind of the decision-maker.

Table 2.4: *continued*

Nr.	Proposition
P 2.10	There will be a positive relationship between the extent to which the area of expertise, or the domain within which the decision-maker acquired experience, match the decision-problem, and the validity of experientially gathered knowledge.
P 2.11	There will be an inverse relationship between the amount of turbulence in a problem domain and the validity of experientially gathered knowledge for decision-making in that area.
P 2.12	There will be an inverse relationship between the extent to which the decision-maker was emotionally involved while acquiring the experience, and the objective validity of the experientially gathered knowledge.
P 2.13	The effectiveness with which a decision-maker will be able to reduce the uncertainty by making use of rational analysis will be moderated by various bounds imposed on the rationality of the decision-maker.
P 2.14	The extent to which a decision-maker will be able to reduce uncertainty by exclusively using rational analysis will be strongly moderated by time pressure.

2.3.6 Construction of a Theoretical Model

Theorists and practicing decision-makers agree that the use of both the intuitive system and the rational system potentially contribute to the reduction of uncertainty in all decision-making. Most decision-making therefore occurs as quasi-rational thinking (Hammond and Bremer 1973). Quasi-rational thinking is conceptualized as a combination of analytical and intuitive cognitive processing (Shapiro and Spence 1997; Simon 1997). The relative potential contribution of each of the systems will depend on the task conditions en-

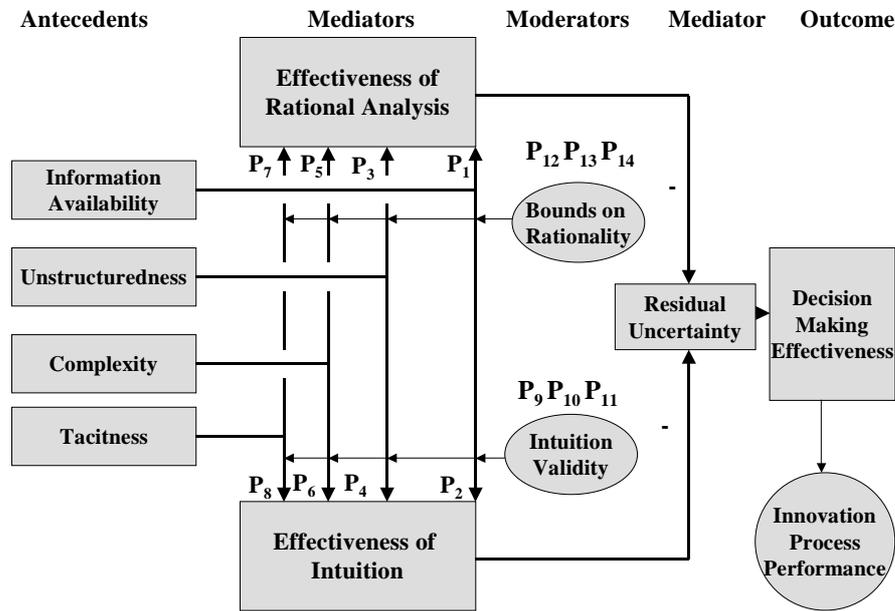


Figure 2.5: Task Conditions, Relative Effectiveness of Fundamental Information Processing Modes, and Moderators of their Validity.

countered by decision-makers, and on the presence of moderators influencing the effectiveness of each of the cognitive mechanisms. In Figure 2.5 we summarize the theoretical model, based upon the propositions developed earlier.

2.4 Conclusion

The main purpose of this chapter was to develop coherent theoretical insight, at the level of the individual decision-maker, into the appropriateness, potential benefits and liabilities of different decision-making styles under various conditions. The underlying aim of the study was to determine which style would, at least theoretically, lead to the most effective decision-making in

the high-tech service innovation process. The work consisted in a thoughtful evaluation and recombination of existing theories in the field of cognitive psychology and decision-making under uncertainty. This has led to a number of new insights, and the construction of a coherent theoretical model. First, it was proposed to extend the cognitive continuum with an extra dimension, the intensity of use of the respective information processing modes. This has led to the distinction of four, instead of two fundamental decision-making styles, allowing a distinction between substantially different forms of semi-rational decision-making, strategic sense making on the one hand and heuristics on the other. Second, the two underlying cognitive styles were related to realistic task conditions and we indicated which style would be preferable under which task conditions. Finally, based upon the input of the decision-making styles, propositions were formulated with respect to the factors moderating the effectiveness of the use of different styles. These propositions were integrated in a comprehensive model.

As was argued at the beginning of this chapter, task conditions are not constant during the new service development process. An evolution will take place from extreme uncertainty at the outset, to a level that can be managed with rational analysis at the moment of launch. Based upon the model we have developed, we argue that under the circumstances of relative problem ill-structuredness, complexity, lack of data, inarticulateness and time pressure that occur at the outset of the new service development process, decision-makers could gain increased control by using intuitive cognition. The further decision-makers proceed in the innovation process, the more information will become available, and problems will become more and more structured. During this stage, active sense making would be the most appropriate style. At the end of the process, we expect that most decisions

can be made on a mainly rational basis. With respect to the effect of the moderators that were identified, we expect that, especially at the outset of a new service development process, managers with accumulated experience and who developed expertise in the high-tech service innovation context to be relatively more effective and to be faster decision-makers. However, in view of the presented conceptual model, the validity of experientially gained knowledge will be highly dependent on the relative stability of the problem area and the efforts and ability of the decision-maker to keep up with changes in their field of expertise or experience.

2.4.1 Managerial Implications

A recommendation to decision-makers would therefore be, to be careful with both overly intuitive (inductive) and overly rational (deductive) decision-making strategies in very turbulent decision environments. Under these conditions, it seems, it is in the first place necessary to be ‘up-to-date’ and very knowledgeable about trends and developments, such as changes in customer requirements and technology, and second, whenever possible to validate personal insights with insights of peers active in the same environment. This strategy could compensate on the one hand for a lack of valid individual experience and on the other hand for the lack of time needed for reliable rational decision-making.

A general recommendation to the high-tech service firm would be to deploy the most experienced⁴and up-to-date product managers in those new service development processes involving the greatest uncertainty and requiring the greatest speed. At the same time, it seems advisable to let these managers confer with peers and validate insights with colleagues. Group

⁴In terms of *decision-making*.

decision-making, provided that the group consists of experts, may be preferable in case of very important and highly consequential decisions.

2.4.2 Limitations and Suggestions for Further Research

The scope of the present study was limited. A range of areas has been revealed requiring further attention. In the first place, a conceptual model was developed, which needs to be operationalized. Reliable measurement instruments must be developed, in order to allow a quantification of the relationships between different constructs. This is needed to obtain better insight in the relative importance of various antecedents and moderators of effective decision-making and their dependence on task conditions. Furthermore, the cognitive continuum was reconceptualized as a matrix with four quadrants. Although a fair amount of experimental research has been conducted with respect to the two traditional decision-making extremes, intuitive and rational decision-making, as well as with respect to heuristics and routine decision-making, research into the information requirements and validity of the hybrid style of active sense making, which seems to play a much more important role in dynamic and complex business environments, and probably in scientific and medical problem solving as well, is entirely lacking, but seems now of the utmost importance.

In the present discussion an abstract and very general definition of uncertainty was used; the absence of knowledge that is relevant for the decision problem at hand. Uncertainty was thus conceptualized as ignorance that in principle could equally well be reduced through rational and intuitive knowledge. Uncertainty can take many forms, however. In order to further operationalize the model, more behavioral detail is needed. However, decision conditions vary substantially between industries. To develop a better under-

standing of the nature of the uncertainty confronting decision-makers, and to obtain more behavioral detail we suggest that case studies be conducted in various industries. This could then lead to the construction of a more specific model that can be operationalized and validated. Each of the task conditions must be studied as a unique origin of uncertainty, whereby hierarchical effects should also be investigated. Interaction effects between the various factors should be expected and investigated, in order to determine the relative importance of various cognitive skills and the role of electronic decision aids, such as expert systems, artificial intelligence and decision support systems.

The problem of information overload has not been adequately addressed in this chapter. More research is needed in this area, since information overload seems to be a unique antecedent of uncertainty.

Potential advantages and drawbacks of group decision-making in high-tech service innovation processes, as an alternative for individual decision-making, could also be considered and should be studied in detail.

Chapter 3

New Service Development in Mobile Telecommunications

This chapter is based on a case study performed in the mobile telecommunication services industry. In dynamic and uncertain business settings the performance of the new service development process depends increasingly on the ability of individual managers to stay in control of the process, i.e. to make effective decisions fast. We articulate the decision-makers' unique task conditions and identify antecedents and moderators of effective decision-making in four high-tech service innovation projects. Findings are integrated in a theoretical framework. The study reveals the crucial role of decision-makers' balanced use of diverse cognitive skills, their proactive attitude, and their capability to mentally represent innovation interfaces with the customer, technology and the firm.

3.1 Introduction

Rapid technological developments, never-ending change in customer requirements and hypercompetition characterize high-tech service industry sectors such as the mobile telecommunication services business (Bogner and Barr 2000; D'Aveni 1995; D'Aveni 1994). As a result of the turbulence, most high-tech services have very limited life cycles and continuous innovation has become a necessity for survival in the industry (Lehmann 1997). However, many new information and communication technology (ICT-) based services fail to meet expectations with respect to financial performance or with respect to the creation of customer value (Cooper and Edgett 1996). Since investments in high-tech service innovation projects are high, as well as the current failure rates, an urgent need exists in the industry to increase control over the innovation process (Cooper 1996).

Most previous research regarding success factors in service innovation has focused on issues external to the new service development (NSD-) process (Edvardsson et al. 1995). Nevertheless, in very dynamic industry sectors, factors internal to the NSD process have become increasingly important. In these sectors, companies generally employ an organic (Burns and Stalker 2001) and flexibility oriented organization structure (MacCormack et al. 2001), and many have implemented highly decentralized decision architectures. As a result, the performance of the individual decision-makers in charge of innovation projects is playing an increasingly important role with regard to the success of the new service development process as a whole.

In previous service innovation research the efficacy of communication and information processing efforts have already been put forward as important antecedents of NSD project performance (Lievens and Moenaert 2000b; Lievens and Moenaert 2000c; Lievens et al. 1997). In fact, decision-making is the

ultimate way managers process information and transform it into action and maintain control over the process (March 1999). Therefore, the ability of individual decision-makers to acquire, integrate and coordinate information and expertise from different sources and functional domains, and to transform this information into a pattern of effective decisions, must be considered a crucial determinant of the performance of high-tech service innovation projects.

In this chapter we explore antecedents of effective high-tech service innovation related decision-making at the level of the individual manager. Three research questions will be addressed in the study, centering on an articulation of the decision-maker's task conditions, and the identification of necessary personal as well as of organizational antecedents of effective decision-making:

- RQ 1:** *What do the task conditions of innovation project managers consist of, in the high-tech service industry?*
- RQ 2:** *Which cognitive and organizational skills contribute to more effective decision-making of project managers?*
- RQ 3:** *How can firms facilitate effective decision-making in the high-tech service innovation process?*

A case study has been developed in order to explore decision-making in ICT-based service innovation.

We have structured this chapter as follows. Since features of the industry's macro-environment will affect the task conditions of the decision-makers, first an analysis of the mobile telecommunication services industry in the European Community (EC), where the study was performed, is presented. Based upon this analysis, the research design is presented as well as

the criteria used in order to select the cases. We then present the cases and findings from the study. Based upon these findings a theoretical framework is constructed. Finally we formulate a series of managerial implications and suggestions for further research.

3.2 The Mobile Telecommunication Services Industry

Decision conditions vary substantially between industries, since the macro context of an industry strongly affects the task conditions of managers active in that industry. It is therefore important to study the innovation process on an industry-by-industry basis (Judge and Miller 1991). We decided to study the phenomenon of innovation related decision-making in the mobile telecommunication services industry, because this industry stands out for reasons of extreme dynamics, complexity and uncertainty. A unique industry structure, a highly competitive environment and quickly changing customer requirements, as well as fast and unpredictable technological developments, standardization wars and rather arbitrary government regulations are the factors that determine the macro environment of the industry. We start with an analysis of these factors and describe the impact of the factors on the task conditions of the decision-makers.

3.2.1 Deregulation of the Industry and the Current Competitive Situation

The telecommunication services industry is one of the most dynamic sectors of the European economy. After partial deregulation of the national telecom-

munication markets in the EC, and the subsequent privatization of the state-owned telecommunications providers, only a limited number of operators are admitted in each country. The national markets for telecommunication services are therefore currently characterized by intense competition between limited numbers of rivaling firms. The relentless competitiveness of the industry directly affects the working conditions of the managers. A number of potential benefits have generally been associated with accelerated product development and a faster speed-to-market in the very competitive settings present in the high-tech services industry (Kessler and Chakrabarti 1996), although no universal empirical support has been found for the relationship between faster product development and competitive advantage (Bayus et al. 1997; Ittner and Larcker 1997). The existing rivalry thus leads to substantial pressure with respect to the speed with which the product managers bring new products to market. Apart from this universal competitive pressure, there is additional external pressure on companies active in the telecommunication services industry in the EC, which affects the innovation process. Recently, national governments in the EC have auctioned new frequency ranges, needed for high-bandwidth communications, at unprecedented prices. Communication providers were virtually obliged to make excessive investments in order to acquire the licenses in the first place. Second, they were also obliged to upgrade the network infrastructure. This has resulted in huge debts, strongly affecting telecommunication stock performance, threatening the survival of some operators, and increasing the pressure on the management of all players. The resulting need to use resources effectively also leads to attempts to reduce new service development time and increases the time pressure on the decision-makers.

3.2.2 Changing Markets, Customer Requirements and Hypercompetition

In the past decade, the market for telecommunication services has radically changed. Initially, the number of new users of basic mobile communication services grew very rapidly, but in the EC the market size now approaches saturation. This has fundamental consequences for the importance of new service development. Cross selling of new high-tech services to a relatively stable customer base has become an important growth strategy. At the same time, consumption patterns and customer requirements change continuously, and services become rapidly obsolete, resulting in increasingly short product life cycles. New and improved technologies and services are introduced on a very regular basis and the time companies can reap the fruits of innovations is thus limited. Due to the increasingly global nature of the telecommunications industry, ideas spread rapidly and the swift imitation or adaptation of successful products has become a universally adopted strategy. This results in a hypercompetitive marketplace, making a fast and efficient new service development process an essential competitive competence. Virtually without exception, all surviving operators in the European market are therefore highly innovative and dynamic companies, with a firmly competitive culture.

3.2.3 Technological Change and Competing Standards

Technological change is without doubt one of the factors contributing most dramatically to the dynamics of the technology-driven telecommunication services industry. On the one hand, rapid developments occur continuously in the design and features of hardware, software and systems used for communication. The current developments in the electronics and software industries

are reminiscent of Schumpeter's waves of creative destruction, provided that they are continuous (Schumpeter 1934). As a result, the bandwidth and speed of available networks and communication devices have been increasing exponentially, paving the way for all sorts of entirely new services. Concurrent developments affecting the industry are media convergence and the integration of mobile phones and handheld computers into so-called wireless digital assistants (WDA). On the other hand, new communication technologies such as GPRS, UMTS, DoCoMo's I-mode and M-stage etc. compete in order to become global standards. At the same time, proposed interface standards like Bluetooth, a wireless protocol governing the connection between mobile devices and desktop appliances such as computers and peripherals, and new regulations communications services have to comply with are introduced on a regular basis. All these changes contribute to the ambiguity, uncertainty, unpredictability and complexity of the industrial macro environment and of the task conditions of decision-makers alike.

3.2.4 Consolidation

Finally, the structure of the telecommunications industry is currently characterized by considerable instability. In part inspired by the difficult conditions firms encounter, there is at present substantial consolidation activity. Strategic alliances, mergers and acquisitions, aimed at achieving economies of scope and scale, affect decision-makers at a product level indirectly, as they cause changes in organizational settings, rapid turnover of top management and frequent radical changes in strategic objectives. They also cause frequent shifts in the competitive landscape, creating a need for a high level of awareness and responsiveness to these changes.

3.3 Research Design

A case study was developed in order to investigate the high-tech service innovation process in the mobile telecommunication services industry in detail. The case study methodology is appropriate for the study of contemporary phenomena, when there is a strong interrelationship between the phenomenon under scrutiny (decision-making effectiveness) and its immediate environment (the high-tech service innovation process), whereas it is difficult to separate the two (Yin 1993; Yin 1994). We make use of a method proposed by Eisenhardt (1989) and Lievens et al. (1999a) designed to enable the construction of a theoretical framework from our observations by means of induction (Judd et al. 1991). In order to increase the validity of our constructs we apply a heuristic method of iterative concept development (Kerlinger 1986).

3.3.1 Sampling

In the choice of cases, a purposive sampling strategy was employed. Cases needed to be selected in such a way that their investigation would optimally contribute to the understanding of the interrelation between task conditions, decision strategy and the probability with which decisions contributed to a successful new service development project. Therefore selection criteria were chosen for the innovation projects based upon two dimensions. To allow the identification of factors that would make a critical difference between successful and non-successful projects, i.e. projects leading to a successful or a non-successful service, the extent to which the company considered the resulting new service to be successful was chosen as a first dimension. By asking two experienced managers to select the successful and unsuccessful

cases from a wide range of both supporting and core services, it was assured that they used a balanced set of performance indicators (Easingwood and Percival 1990; Easingwood and Storey 1993), and did not treat new service performance as a single dimension (Cooper and Kleinschmidt 2000).

On the other hand, the task conditions were expected to vary substantially with the extent to which the new service could be considered innovative. The second dimension thus covered the continuum between services that were new to the organization, but not to the market (so-called me-too innovations) and services that were entirely new to the market as well as to the organization (really new services). The objectives of the research as well as selection criteria for the innovation projects were presented to two senior staff members of a large European mobile telecommunication service provider. They selected four cases from the large number of innovation projects the company had completed over the past years, and provided the researchers with access to company documentation with respect to the projects and staff involved in the respective projects. Figure 3.1 represents the chosen case study design.

3.3.2 The Research Site

First, the features of the focal company are described that are relevant for a good understanding of how the innovation process is embedded in the organization. This focal company, a subsidiary of one of Europe's former state-owned telecommunications companies, is like most of its competitors a relatively new player in the field. Founded only a few years ago, managers and staff alike are relatively young, highly dynamic, and moderately inexperienced, enthusiastic workers with a highly proactive 'learning' attitude. Partially due to the relatively short existence of the subsidiary, partially due to industry dynamics, the organizational structure had not entirely crystal-

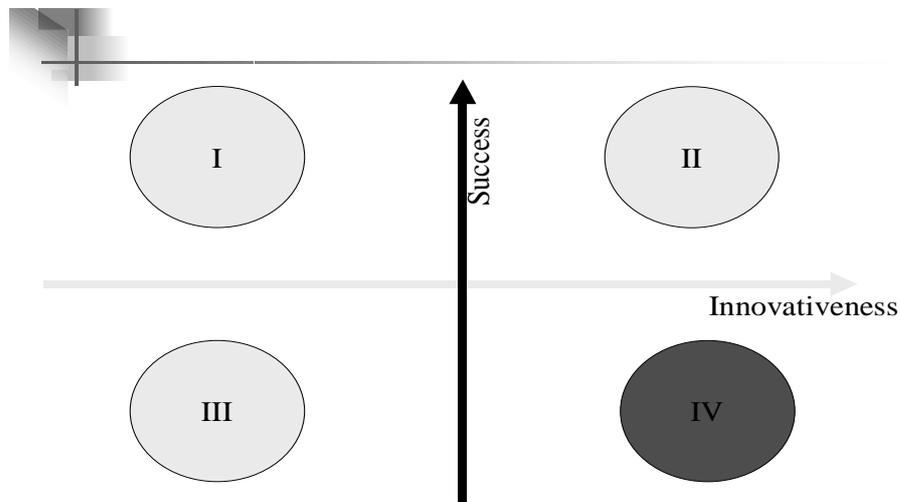


Figure 3.1: Case Study Design

lized at the time of the case study and was considered flexible and being adapted to the changing requirements. A major choice, however, having had a considerable effect upon the organization of the innovation process, was the decision to use an adapted stage-gate process model for new service development (Cooper 1992). This provided the innovation process with a comparatively structured framework. The adapted stage gate process model allowed for the coordination of parallel development activities in different functional departments, all related to the same innovation, and thus reduces the product development time, albeit at the cost of higher complexity. The gains in terms of development speed were considered more important, however, than the disadvantages related to an increase in complexity.

3.3.3 The Case Study

The first innovation project that was investigated (project I, successful, me-too service) was the development of a voice- and fax mail service. The unique benefit of the service consisted in offering the consumer the possibility to retrieve, at the moment of their choice, voicemail messages and faxes having arrived, while their mobile phone was switched off or when they were unavailable. This service had already been commercialized successfully by competitors between six months and a year before the establishment of the focal company. As this was a me-too innovation, there was tremendous pressure from top management, to get the service fast on the market. At the same time, the service had to offer a great degree of user-friendliness, if possible more than incrementally improving on the existing competitive offers. It was one of the first new services the company developed.

The second service innovation that was studied (project II, successful, really new service) was the development of an entirely new tariff structure and corresponding invoicing system. Instead of invoicing customers per fixed time unit, which is common practice among mobile communication service providers, the company launched the option to be invoiced by a fixed debit amount. The benefit for the consumer would be the freedom to spend a previously agreed amount of credit on his or her own choice of services. The invoicing system was highly innovative and its benefits to the consumer had to be promoted heavily, since nothing comparable existed.

The third innovation (project III, not successful, me-too service) related to the development of a supplement to existing mobile services. The new service made it possible for the subscriber to display the original caller ID on their phone, of a caller that was transferred to their phone via another number. The basic technology needed for the supplementary service was already

embedded in the network design. Service development therefore consisted of a rather technical implementation process within the company, assuring compliance to legal and technical standards. Complexity was very high, and although the service was implemented successfully in terms of the technological and regulatory requirements, it was not considered a commercial success. The service was originally developed in compliance with a large contract with an important business customer that did not allow any deviations from the original specifications.

The last project being selected (project IV, not successful, really new service) was the development of a premium branded service offer. The idea behind the new service package was to introduce an executive communications package that typically included the most sophisticated communication device on the market, and offered all possible advanced options, most of which were already available to other customers against extra charges. There was strong pressure from the parent company to develop this package, as the idea was originally theirs. However, the subsidiary had other priorities at that moment, such as developing a broad customer base and positioning their own still rather unknown brand. This resulted in a bad match between the subsidiary's own objectives and operations and the new service. A summary of the distinctive features of the four innovation projects can be found in Table 3.1.

3.3.4 Data Collection and Processing

In the present study a number of data collection methods were combined. Desk research involved the in-depth study of company documents relating to the four innovation projects, such as the original service specifications and progress reports, marketing materials that had been used for the com-

	Project I	Project II	Project III	Project IV
Description	Voice- and Fax Mail	Tariff Structure and Invoicing System	Display Caller ID	Premium Branded Package
Success	Successful	Successful	Not Successful	Not Successful
Novelty	Me-too	Really New	Me-too	Really New
Complexity	High	High	High	Low
Time Pressure	High	Medium	Medium	High
Control	Decentralized	Decentralized	Centralized	Centralized
Benefit	Offers User more Freedom and Convenience	Offers User more Control over Credit and Expenditures	Offers User extra Information and Security	Offers User Luxury and State of the Art Technology
Target Audience	Private and Business	Private and Business	Business	Business

Table 3.1: Features of the Four New Services

mercialization of the new services, the company website, publicly available information such as the mission statement, financial year reports and press announcements. This was done in order to develop insight in the new service development and marketing strategies of the company, as well as in the position of the four new services in the total offer. In the second place, an archive of newsletters from mobile telecommunications providers active in various national markets was studied. Most mobile telecommunication service providers distribute newsletters to their subscribers either in print or via the Internet, and use them to introduce new technologies and services and explain their sometimes highly complicated benefits. Here, the purpose was to develop a better appreciation of the industry and its dynamics.

After thus having developed an understanding of the company, its relative position in the industry, and the prevailing macro-environmental conditions, the researchers proceeded to the field research. In-depth interviews were conducted with decision-makers involved in each of the innovation projects, with a technical manager involved in a number of projects, as well as with two top managers. These interviews were conducted in as open a format as possible. An interview guide was constructed, based upon the research themes mentioned and a selection of relevant managerial decision-making literature (Hammond 1996; Hastie and Dawes 2001; March 1999; Weick 2001) and writings on service innovation (Lievens and Moenaert 2000b). Most interviews lasted between an hour and ninety minutes. The interviews were transcribed in their entirety. The transcripts were studied in terms of their content, with the double objective of identifying recurring themes on the one hand, as well as capturing the differences in terms of task conditions and innovation performance between the four projects on the other. Additionally, the research team met on a regular basis with key informants at the company,

to discuss the progress and findings of the study. Finally, during a feedback workshop, the interviewees were confronted with a preliminary model that was developed based on the findings, and their comments were subsequently used for further refinement of the propositions. This was done in order to increase the internal validity of the model.

3.4 Case Study Findings

With the purpose of developing a better understanding of the nature of the problems the decision-makers experienced in the high-tech innovation process, they were asked to describe what they considered to be effective decision-making. The researchers then asked them to articulate the unique circumstances and challenges they encountered during high-tech service innovation projects.

From the interviews it became clear that in an innovation project large numbers of interrelated and interdependent decisions have to be made. According to the decision-makers, due to the parallel organization of the new service development process, decisions were often made that actually required knowledge of other choices that were made only later on in the process. As a result of the interdependency and interrelatedness of decision outcomes the ‘valences’ of options of one decision often depend on other choices later on in the project. Hence, again according to the interviewees, it is often very difficult to judge the ‘quality’ of individual decisions, or their individual contribution to project performance. Even *ex post facto* it often remains difficult to judge whether or how any particular decision contributed positively to the success of the new service development project. One manager formulated this dilemma of decision-making as follows:

‘Often you simply have to make a decision, and as a result of the uncertainty and complexity you simply cannot decide which option is best. No one ever could. However, for the sake of progress, you simply make a decision and later on, when things have become a bit clearer you make adjustments as you go’

In contrast with theories of rational decision-making, where it is, at least in retrospective, possible to calculate for each particular decision which option was optimal (Schoemaker 1982; Von Neumann and Morgenstern 1947), we use the concept of ‘effective decision-making’ in the present study, not focusing on the rationality of individual decisions, but rather on the rationality of the process of decision-making as a whole. Since the concept of the quality of individual decisions cannot be universally defined in this highly complex context, ‘effective decision-making’ is defined, in agreement with the interviewees, as making decisions in such a way that, on average, the decisions contribute positively to maintaining control over the process, i.e. maintaining an appropriate balance between speed and quality of the new service development process. In this sense, effective decision-making contributes positively to the performance of the new service development project and ultimately to new service success. In ICT-based service innovation projects, the performance of the new service development process is thus moderated by the effectiveness of decision-making at the level of individual decision-makers in charge of the projects.

3.4.1 Factors Threatening Decision Making Effectiveness

Having decided on the dependent variable of the research, i.e. the effectiveness of decision-making, the interviewees were asked to describe the factors directly affecting decision-making effectiveness in the new service development process. Three major recurring themes were identified in all recorded accounts, regarding the task conditions. The decision-makers described their decision-making effectiveness, or the extent to which they were able to exert control over the process, as most powerfully threatened by the typical combination of dynamic complexity, uncertainty and time pressure they encountered in their work. By further probing, a more detailed picture of these three factors was obtained.

3.4.1.1 Interactive Dynamic Complexity

The first issue that came up in most interviews was the tremendous complexity of many decision problems. The managers specified that the *number of issues* that had to be dealt with in the decisions was not the only explanation for the problem complexity. Most of the time, they would have to take into account a large number of interdependent issues from multiple disciplines and perspectives. The state of affairs in some of these areas was relatively stable (e.g. organization structure, resources and capabilities), whereas it was in a constant flux of change in other areas (e.g. market, technology and regulatory environment). The complexity was increased by the fact that most innovation projects in our focal company were not divided into a series of consecutive projects, but rather into a number of interdependent projects that were partially run in parallel. As we already discussed, each decision

with respect to one part of the project, in turn affected the available decision options and their valences in other parts. A major challenge for the decision-makers was to make sense out of what has appropriately been called this interactive dynamic complexity (Weick 1990). We therefore propose:

Proposition 3.1 *In high-tech service innovation projects, decision-making effectiveness is negatively related to the perceived level of task complexity.*

When we probed further into the nature of the interactive dynamic complexity they had to deal with, the complexity was described as a function on the one hand of the number of issues to be considered, the multidisciplinary nature of the issues, their interrelatedness and their changeability.

3.4.1.2 Uncertainty

Permeating all managerial decision-making, but decision-making in high-tech service innovation projects in particular, is a high level of uncertainty. Uncertainty in the innovation project was articulated as the extent to which reliable and detailed knowledge of important issues was not available to the decision-maker at the moment the decision had to be made. Decision-makers acknowledged that the innovative uncertainty could only be reduced to a certain extent and that relatively high levels would always persist throughout the project. They considered uncertainty in the high-tech service innovation process to be an important trade-off with respect to speed. Most managers were very well aware of this trade-off, as well as of the fact that in high-tech service innovation projects a firm amount of residual or irreducible (Hammond 1996) uncertainty is inevitable. At the same time, perceived task uncertainty, they felt was a major threat to effective new service related decision-making (Daft and Lengel 1986; Tushman and Anderson 1986). Consequently, we propose:

Proposition 3.2 *In high-tech service innovation projects, decision-making effectiveness is negatively related to the perceived level of task uncertainty.*

Factors contributing most to the perceived task uncertainty were the novelty of the service in an absolute sense, i.e. its novelty to the world or the market, but also its relative novelty to the organization. Much of their task uncertainty was also related to the technology involved. Certainly at the beginning of a project, the nonexistence of reliable information on the precise specifications of the new service, or the precise requirements from the market, the relationship between the new service and the existing portfolio of services, the precise technology, regulations etc. caused high levels of uncertainty. In the course of the project, the uncertainty would indeed be gradually reduced in some areas, but it could still increase in other areas, as it was affected by competitive actions, and by changes in technology and regulations or company policy.

3.4.1.3 Time Pressure and Stress

Another phenomenon all managers found to be threatening their decision-making effectiveness was the combination of time pressure and stress. In industries such as the telecommunication services industry, where services have exceedingly short life cycles, there is often extreme time pressure. Even a small delay in the innovation project can make the difference between a great success and a failure. The circumstance that for the focal company many innovations were me-too innovations even increased the time pressure. These so-called me-too innovations had already proven successful elsewhere. If the new service had been commercialized in the market where the focal company was active, a fast time to market would decrease the first-mover advantage of directly competing firms. If the innovation had been commer-

cialized in other markets, e.g. by the parent company, the focal company could be the first to introduce the service in their market and thus enjoy a first-mover advantage. In both cases pressure to get the service out as fast as possible was very high.

Decision-makers described the time pressure sometimes in a negative sense, as a 'lack of time'. Time pressure indeed reduces the time available to do project based research, i.e. to collect and process information related to the service under development and thus to reduce the task uncertainty. This in itself was considered an substantial challenge. However, after some probing, it was also acknowledged by the managers that they perceived time pressure as more than simply a lack of time. It was also, more positively, experienced as pressure, which could lead to variable amounts of stress. The decision-makers stressed that they did not necessarily and always experience this as a negative thing, since a certain amount of stress is known to increase creativity and productivity. Severe stress is known to affect judgment quality negatively, however, through a reduction of the consideration set. We therefore propose:

Proposition 3.3 *In high-tech service innovation projects, there exists a curvilinear (inverted u-shaped) relationship between time pressure and decision-making effectiveness.*

In the two projects considered to be unsuccessful, we detected another source of stress. Role ambiguity, i.e. the absence of decision authority, where the decision-makers were actually the most knowledgeable employees, was also felt to contribute directly to a feeling of stress.

3.4.2 Antecedents of Effective Decision Making

Even under the extreme conditions of dynamic interactive complexity (Weick 1990), uncertainty, and time pressure surrounding their work, decision-makers continuously have to make decisions, and have to make these decisions coherently, fast and confidently. The purpose of the second research question was to identify major antecedents of effective decision-making under these task conditions. In the interviews, we therefore asked the managers in the first place, which skills helped them most to make the decisions effectively, i.e. to make decisions that would on average increase their control over the process and contribute to the probability of success of the projects. We recorded two categories of answers. One category was related to the cognitive skills the managers employed in order to deal with the challenges in their task. The second category had to do with more psychological skills employed to deal with the negative effects of uncertainty, complexity and time pressure.

3.4.2.1 Cognitive Antecedents

The interviewees without exception affirmed that the difficulty of their task demanded much of their cognitive skills. They also all agreed that the difficult task conditions could be best dealt with by employing a *balanced combination* of rational analysis, common sense and intuition.¹ None of the decision-makers had a clear preference for any of the mentioned cognitive styles; all agreed that it was precisely their flexibility in choosing the appropriate style at the right moment that enabled them to deal with the task. They stressed

¹The fourth decision-making style we identified in Chapter 2, 'active sense making', was not explicitly mentioned by the interviewees; they stressed that an appropriate *balance* of decision-making styles should be achieved, without going into much detail as to which decision-making styles they employed.

that it was largely a matter of experience² to know which decision style should be used best under which conditions, in order to maintain control over the speed and quality of the process.

When we probed further into the appropriateness of the use of different styles, they affirmed that rational analysis was used most appropriately, as far as possible with respect to the relative lack of hard data, in the cases where highly consequential decisions had to be made, e.g. at the gates of the stage-gate process. The process of rational and decision-making and explicit justification of the outcome, although by all decision-makers considered to lead to high quality decisions, was considered the most time consuming of the three styles. For reasons of time pressure and lack of data it could simply not be applied all the time, and explicit rational analysis was therefore generally concentrated around the gates. These were also the moments when their decisions had to be justified to top management. All decision-makers perceived these moments as the anchor points of the projects, the moments that complexity and uncertainty were forcibly and temporarily reduced to a relative minimum. These were also the scarce moments of reflection that made them really feel in control of the project. We propose:

Proposition 3.4 *In high-tech service innovation projects, a positive relationship exists between the extent to which rational analysis is appropriately used and the extent to which the decision-maker succeeds in dealing with the uncertainty and complexity of the task.*

Obviously, at many times during the projects information was very scarce and time pressure and complexity overwhelming. At these points in time,

²The kind of experience the interviewees referred to here should be seen, not as the amount of time they spent in the industry, but rather as the amount of time they spent making professional decisions.

insufficient information was available for any kind of reliable rational analysis. On the other hand the turbulence of the environment did not give them the feeling that they could trust their intuition either. In such moments they said they would simply use as much common sense as possible. Knowing that they would arrive at one of the anchor points of the projects sooner or later, when they could revise their decisions based on a more detailed analysis, they would make use of *fast and dirty* common sense. Between the anchor points, common sense was considered the option providing the best balance between speed and effectiveness. We propose:

Proposition 3.5 *In high-tech service innovation projects, a positive relationship exists between the extent to which common sense is appropriately used and the extent to which the decision-maker succeeds in dealing with the uncertainty, complexity and time pressure of the task.*

Another cognitive skill they used at set times was their intuition. They used their intuition to counter the uncertainty and complexity of decision-tasks, when they felt they had a lot of useful personal experience, or when the complexity was such, that it was difficult to articulate arguments. They also used their intuition when decisions had to be made based upon their insight in customer requirements, when there was no time for market research and no hard data were available. Intuition was hardly ever used for arriving at the ‘*hard*’ decisions at the anchor points, but instead it was regularly applied as a sanity check of the conclusions. They felt that their intuition sometimes functioned like their conscience. We therefore propose:

Proposition 3.6 *In high-tech service innovation projects, a positive relationship exists between the extent to which intuition is appropriately used*

and the extent to which the decision-maker succeeds in dealing with the uncertainty and complexity of the task.

3.4.2.2 Psychological Antecedents

We continued with the psychological aspects of the difficulty of their task. The interviewees all considered their individual proactive attitude towards the difficulties of innovation projects to be an important asset. The decision-makers told, that it was often a mix of personal and professional ambition to master the complexity, and their attitude to see the difficulties as a challenge rather than as a problem, that actually helped mastering them. We will refer to this mind-set as their proactive attitude and propose:

Proposition 3.7 *There will be a positive relationship between the proactive attitude of the decision-maker and the extent to which they succeed in dealing with the uncertainty and complexity of the task.*

They added in the margin that they could keep up their spirits largely because they felt confident that they could deal with the uncertainty, complexity and time pressure.

3.4.3 Expertise as a Moderator

The interviewees acknowledged that as a result of their difficult task conditions, nobody would make ‘the right decisions all the time’. At the same time, however, they stressed that what they called ‘their expertise’ strongly supported them in whatever cognitive skill or attitude they used in order to deal with the complexity, uncertainty and time pressure in their tasks, or as one manager expressed it:

‘We are the experts’ (in the innovation project) ‘and there is simply no one else who could actually make adequate decisions’.

Having identified decision-makers’ *expertise* as an important moderator of their effectiveness in dealing with the task, we subsequently asked them to explain what they thought their expertise consisted of. It appeared that they did not conceive of their expertise in an entirely traditional sense, as a domain related expertise or skill. What they referred to was actually a multidisciplinary proficiency in their job as managers of high-tech service innovation projects. In order to get a better grip on this complex concept, we asked for their own interpretation of expertise. It became clear that what they referred to, was their unique grasp of the coherence between the ‘the features of the new service’, ‘the organization of the new service development process’ as it was practiced in the focal company, and various interfaces of the new service with relevant dimensions of reality. When we inquired further into the concept of expertise, it became apparent that the interviewees thought, that the application of skills was moderated by the extent to which the decision-maker possessed an adequate mental image of the new service itself. This mental image was delimited by its *interfaces* or contact points with the organization, the customer and the market, the technology and the regulatory environment. In the following we discuss these interfaces, as the decision-makers described them, in some more detail. We have graphically represented decision-makers’ mental image of the new service and its four interfaces in Figure 3.2.

3.4.3.1 Service Organization Interface

As a first aspect of the adequate mental representation of the service, the decision-makers brought up a good understanding of the fit between the new

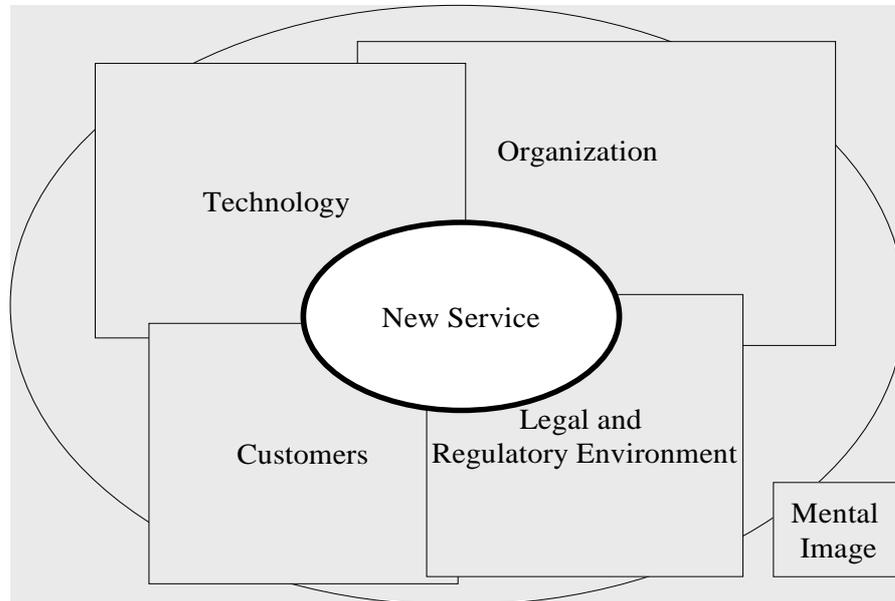


Figure 3.2: The New Service and its Interfaces

service and the organization. Superior insight in the service-organization interface substantially helped them in dealing with uncertainty, complexity and time pressure, which would in turn lead to more effective decision-making. This insight was deemed especially important for a smooth coordination of the innovation project. The decision-makers mentioned that a profound understanding of the organization structure, its culture, its dynamics and the prevalent resource allocation mechanisms, which they got to know during previous innovation projects, was very helpful in ‘picturing’ this interface accurately. Time pressure made this knowledge even more valuable. As there was a need for fast decisions, their understanding of the decision process from previous projects was considered very valuable. At the same time, they recognized that a good understanding of the service-organization interface was what they lacked most in the early projects and what made a timely

completion of their first projects very difficult. An accurate mental image of the service-organization interface contributed to a realistic representation of

‘What is possible and feasible’

Having this realistic mental image of the organizational possibilities, with respect to the innovation, meant that they would come up faster with more relevant decision options, which in turn helped them making decisions *faster*. Their experience with the innovation-organization interface taught them not necessarily ‘which option to choose’, but rather what the relevant options were, thus contributing to more effective and faster decision-making. In short, they deemed a good understanding of the service-organization interface very advantageous for the smoothness of the coordination of the projects and the speed of decision-making. Because organizations vary substantially with respect to the emphasis they put on the different information processing activities (Moorman 1995), a good understanding of the limitations of organizational information gathering and dissemination activities will also help managers decide which supplementary information they need and how to obtain this, in order to reduce the uncertainty more effectively. We therefore propose:

Proposition 3.8 *The extent to which the decision-makers can use their cognitive skills in order to deal successfully with the task conditions will be moderated by the extent to which they mentally represent the service-organization interface accurately.*

Insight in the service-organization interface was largely based on experience acquired during previous projects. During the interviews, most managers explicitly contrasted their experience with the service-organization interface,

in terms of its usefulness, with e.g. the technical knowledge they had obtained in previous projects. They stated that it was extremely difficult to use e.g. technical details they had learned in previous projects, because the services they developed had often very little in common with respect to the technology. They also noted that ‘technology moves forward with the speed of light’, rapidly making their experience in that area obsolete. All confirmed that the service-organization interface was the domain they actually *learned most* in.

3.4.3.2 Service-Customer Interface

Although high-tech service innovation is often considered largely technology driven, all decision-makers we interviewed stressed that a firm customer-orientation and a good understanding of customer requirements were necessary conditions of effective decision-making. Consequently, the second interface deemed important by all decision-makers was the interface between the new service and the customer. The decision-makers contended that they made many of their decisions, whilst keeping in mind their private comprehensive understanding of customer requirements, or as one manager called it:

‘The feeling how the customer behaves and moves’

In the focal firm, the need for speed often did not allow for extensive project related market research, and as a result, this ‘understanding of the customer’ appeared to play a key role in all projects. In successful projects, ‘customer knowledge’ acted as a success factor helping the project managers to make the right decisions. In the unsuccessful projects however, such as the projects III and IV, the decision-makers’ customer knowledge acted as an ‘*early warning sign*’ or an indicator of potential problems. Especially in decisions with

respect to the service developed in project III, the project manager was not allowed to use this customer knowledge, as the service was developed according to specifications that had been laid down in an inflexible contract. We propose accordingly:

Proposition 3.9 *The extent to which the decision-makers can use their cognitive skills in order to deal successfully with the task conditions will be moderated by the extent to which they mentally represent the service-customer interface accurately.*

When probing into the origins of this ‘customer knowledge’, we noticed that the decision-makers, most of them having a background in marketing, agreed that there are a number of problems with conventional market research in the area of high-tech new service development. In the first place it was often considered to be too time consuming. In an industry where speed to market is assumed to play such an important role in the success of the new services, the trade-off between speed and a higher degree of certainty was crucial. In many cases, according to the decision-makers, an increase in speed was considered to largely outweigh a greater degree of certainty. In the second place, in high-tech services consumer tastes and needs evolve very rapidly, and co-evolve with new technologies that become available. It is therefore very difficult to assess with any certainty how consumer needs and requirements will develop. The intangibility aspect of services, especially prominent in high-tech services where it is very difficult for the consumer to imagine the service until it is actually there, was also mentioned as a problem contributing to the difficulty of assessing consumer reactions to prototypes of the service. In this context, managers repeatedly said that an intuitive understanding of the ‘consumer’ and their ability to imagine and anticipate their requirements and possible

reactions accurately was an important skill in their function, that would help them make the right decisions. Even when modern or alternative ways of product development are used, such as rapid prototyping and evolutionary development (MacCormack 2001), whereby the consumer is participating in the product development process, by e.g. testing Beta-versions, an intuitive understanding of the customer will continue to add value through a better anticipation of customer requirements.

The focal company regularly organized market studies, sometimes at the level of the parent company and sometimes at the level of the subsidiary, thus providing the managers with hard data about general trends and developments in customer requirements. In order to update their representation of ‘the customer’ the decision-makers made use of this information, and merged it with their ‘intuitive understanding’. Their mental representation of the desires and possibilities of the customer based on their own desires and possibilities, corrected for the fact that they considered themselves

‘crazy about telecommunications’

and corrected for their own technical proficiency was complemented and completed with market information from retailers, the Internet and many other sources. One manager remarked:

‘Dealers and retailers, that’s where you get your ‘feeling’ from’.

Decision-makers also said that they make faster sense out of the results of formal market research, the more experience they had in the area:

‘The longer you’re in business the faster you go’.

This can be explained by the build up of absorptive capacity (Cohen and Levinthal 1990) or the capacity to correctly interpret and assimilate new

information. This absorptive capacity is built over the years and grows with experience.

3.4.3.3 Service-Technology Interface

A third aspect of what the decision-makers called their expertise was technology. More precisely, they referred to their non-technical insight in relevant technological developments or what we will call the interface between the new service and technology. Clearly, the decision-makers were not supposed to be technical experts, there were sufficient other people involved in the innovation project with detailed technical expertise. They were however supposed to have the ability to communicate effectively and efficiently with the technical department. They also had to integrate their understanding of technological problems and possibilities in their decision-making. We thus propose:

Proposition 3.10 *The extent to which decision-makers can use their cognitive skills in order to deal successfully with the task conditions will be moderated by the extent to which they mentally represent the service-technology interface accurately.*

When we probed into the origins of this insight, the managers affirmed that more than in other cases they had to use their communicative abilities to extract the relevant information from the technical staff. They had to adapt to the jargon of the technical staff, translate it or project it onto what they viewed as the ‘real human world’ of the service innovation. At the same time, the accuracy of the mental representation of the service-technology interface depends on the decision-maker’s understanding and anticipation of technological developments. A certain affinity and familiarity with informa-

tion and communication technology was therefore considered a prerequisite of an accurate mental representation of the service-technology interface.

3.4.3.4 Service-Regulations Interface

Another important factor, also being mentioned by most decision-makers, was the need to comply with externally imposed regulations and standards. These regulations originated from both the suppliers of the network technology and from governmental regulators. Whereas the three other dimensions for most managers had a positive connotation, implying that better insight would lead to decisions that could contribute positively to the success of the innovation, their understanding of the regulatory environment rather served as a limiting device and better knowledge of the regulatory forces would only lead to a more ‘cautious choice of options’. In the view of the decision-makers, the regulatory environment limited, rather than created opportunities. Nonetheless, the managers agreed that their familiarity with the regulations and the extent, to which they somehow understood their logic, helped them making correct decisions more rapidly. We therefore propose:

Proposition 3.11 *The extent to which the decision-maker can use their cognitive skills in order to deal successfully with the task conditions will be moderated by the extent to which they mentally represent the service-regulations interface accurately.*

For each project the files consisted of many pages of highly technical and legal information. Since they mostly agreed that it was

‘entirely impossible to keep up with changes and know all current regulations’

they would develop an intuitive feeling with respect to the regulations and base most decisions on this intuitive feeling about the boundaries. The propositions are summarized in Table 3.2.

Table 3.2: Overview of the Propositions

Relation	Nr.	Description
Mediator	3.1	Decision-making effectiveness is negatively related to the perceived level of task complexity.
Mediator	3.2	Decision-making effectiveness is negatively related to the perceived level of task uncertainty.
Mediator	3.3	There exists a curvilinear (inverted u-shaped) relationship between time pressure and decision-making effectiveness.
Antecedent	3.4	A positive relationship exists between the extent to which rational analysis is appropriately used and the extent to which the decision-maker succeeds in dealing with the uncertainty and complexity of the task.
Antecedent	3.5	A positive relationship exists between the extent to which common sense is appropriately used and the extent to which the decision-maker succeeds in dealing with the uncertainty, complexity and time pressure of the task.
Antecedent	3.6	A positive relationship exists between the extent to which intuition is appropriately used and the extent to which the decision-maker succeeds in dealing with the uncertainty and complexity of the task.
Antecedent	3.7	There will be a positive relationship between the proactive attitude of the decision-maker and the extent to which they succeed in dealing with the uncertainty and complexity of the task.
Moderator	3.8	The extent to which the decision-makers can use their cognitive skills in order to deal successfully with the task conditions will be moderated by the extent to which they mentally represent the service-organization interface accurately.

Table 3.2: *continued*

Relation	Nr.	Description
Moderator	3.9	The extent to which the decision-makers can use their cognitive skills in order to deal successfully with the task conditions will be moderated by the extent to which they mentally represent the service-customer interface accurately.
Moderator	3.10	The extent to which decision-makers can use their cognitive skills in order to deal successfully with the task conditions will be moderated by the extent to which they mentally represent the service-technology interface accurately.
Moderator	3.11	The extent to which the decision-maker can use their cognitive skills in order to deal successfully with the task conditions will be moderated by the extent to which they mentally represent the service-regulations interface accurately.

3.4.4 Construction of a Theoretical Model

The ultimate purpose of this study was the development of a theoretical framework, integrating the unique task conditions of the ICT-based service innovation process and antecedents of effective decision-making as expressed in the propositions. A model was constructed based upon an analysis of the cases, feedback from the interviewees and key-informants and a match with existing literature. The three prevailing new service development task conditions are viewed as mediators (Baron and Kenny 1986) between decision-makers' use of cognitive skills and effective decision-making. In order to improve the effectiveness of decision-making, the managers in the ICT-based new service development process must deal with these three mediating variables, interactive dynamic complexity, uncertainty, and time pressure. It was proposed, that decision-makers can successfully deal with the factors

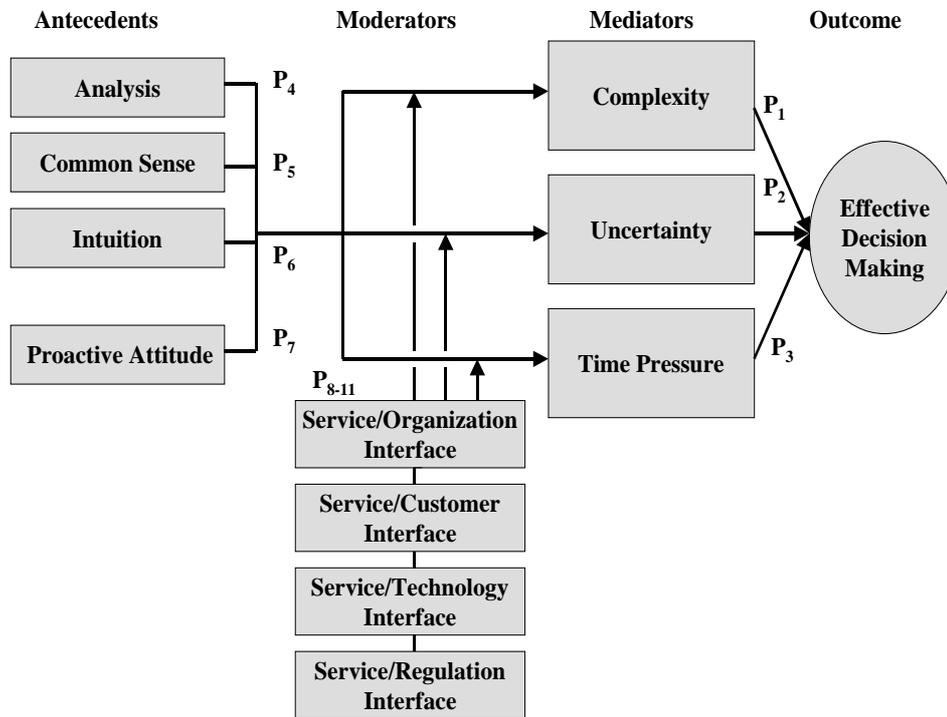


Figure 3.3: Antecedents, Moderators, and Mediators of Effective Decision Making

mediating effective decision-making through the balanced use of a number of cognitive skills and attitudes. Their expert insight in four service interfaces seems to moderate the effect of the antecedents in the new service development process substantially. A theoretical model integrating the propositions is graphically represented in Figure 3.3. The lines connecting the constructs in this model represent the propositions.

3.5 Conclusion

We conducted the present study with the purpose of identifying major determinants of effective decision-making in high-tech service innovation. In the

study we assumed that effective decision-making at the level of the project managers contributes substantially to the success of innovation projects and ultimately to new service performance. Therefore, the focal points of the present study were the decision-makers charged with the supervision of new service development projects. The study has provided us with a number of refreshing insights. In the first place we identified the unique task-conditions of the individual decision-makers, namely complexity, uncertainty and time pressure as major mediators of effective decision-making. In the second place we found antecedents of effective decision-making in the flexible, balanced and appropriate use of various cognitive skills and decision styles: rational analysis, common sense and intuition. On a more psychological level, the 'proactive attitude' of the managers was also identified as an important antecedent of dealing successfully with the difficult task conditions. Furthermore, the expertise of the decision-makers, consisting of their understanding of the interfaces between the new service, the organization, the customer, the technology and the regulations, plays an important role. The expertise of the managers in these areas moderates the effectiveness of the use of their skills in dealing with the task conditions considerably. Based on the present study, we therefore conclude that decision-maker's cognitive skills, an extensive flexibility in the use of these skills, and the presence of expertise, determine the extent to which the decision-makers are able to exert control over the innovation process and to manage the projects successfully. The indispensable expertise of the decision-makers is built up over time as a result of their experience on the job and in the industry.

Apart from this, we also noticed during the case study that the two unsuccessful cases (projects III and IV) shared the common circumstance that the scope of the projects was, as one manager remarked, '*dictated from above*'.

This observation seems to confirm the theory of contingency of organizational decision architecture and environmental conditions, proposing that decentralized decision-making, occurring in real-time is preferable in turbulent market environments (Beach and Mitchell 1978; Moorman and Miner 1998). In both failed projects, more or less complete and rather rigidly defined new service concepts were handed to the decision-makers, with the task to develop the service. In these cases, the decision-makers did not have the authority to deviate from the original design, or even stop the new service development if they felt this to be appropriate. With respect to the Caller ID display technology (project III), an important business customer negotiated the inclusion of the service as part of a larger contract. Neither service specifications nor design were negotiable. With respect to the premium brand service package (project IV), the idea came from headquarters. In both cases, the rather rigid delineation of the projects severely restricted the scope of decision options. The decision-makers lacked decision authority and sufficient resources, notwithstanding the fact that they were the most knowledgeable on the projects and the requirements. As a result, the decision-makers, not able to identify completely with the projects, and therefore not endorsing the projects as their own, considered themselves to be simply carrying out a project. Both managers reported a strong intuitive feeling, that the projects *'weren't right'* for the company or the market. They based their feelings on intuitions about the market, customer requirements and their understanding of the company, rather than on hard data. Although in both cases the decision-makers were probably the most knowledgeable and most experienced decision-makers the company had, they were not allowed to use their experience and intuitions about the product or the product/market combination.

The two successful cases, on the contrary, had in common that the decision-

makers were highly involved in the full design and development of the project and were able and allowed to make use of and integrate their intuitions and common sense with respect to the requirements of the market, the possibilities of the company and the available technology. In the two successful cases, (projects I and II) the decision-makers we interviewed intellectually ‘owned’ the projects. Based upon this observation, an additional proposition could be made, namely that an effective decentralization of innovation related decision-making is a necessary condition of effective decision-making. In a turbulent business environment, the organization should empower the most knowledgeable decision-makers to actually produce the effective decisions they are capable to.

3.5.1 Managerial Implications

Based upon these findings a number of recommendations can be made to firms in the high-tech services industry. In the first place, we would obviously recommend carefully selecting candidates for the function of decision-makers in charge of high-tech service innovation projects. The task conditions are very demanding with respect to candidates’ cognitive skills and their flexibility in using them. Candidates must possess both the necessary skills and the ‘proactive attitude’ to deal with the combination of dynamic interactive complexity and time pressure and must possess a strong desire to learn in many different disciplines. They also need to possess a non-dogmatic approach to dealing with information and decision-making, in the sense that they must allow common sense, creativity and intuition to support or complement more analytical techniques. Candidates, dogmatically tending to an either purely ‘analytical’ or to an entirely ‘intuitive’ approach, seem less suitable in this context. With respect to the expertise of candidates, it seems that it takes

time to acquire the necessary know-how and therefore it would make sense to select candidates that already had the opportunity to get to know the innovation process and the organization from the inside, rather than external candidates.

In quickly evolving environments, decision-makers need to remain up-to-date in all areas. In the first place, the organization may therefore consider supporting the decision-makers by introducing an adapted high-velocity information acquisition and diffusion system. The intelligence system should keep track of developments in the market, the competitive environment and the technology and make this information available in real-time to the decision-makers in an efficient way. In the second place, we recommend that in highly dynamic and complex environments the individual absorptive capacity of the decision-makers be actively maintained. The firm could create favorable conditions by letting the decision-makers attend training seminars and conferences in all relevant disciplines.

An additional condition of effective decision-making was identified in the autonomy of the decision-makers to use their insights and decide about the project, i.e. the extent to which innovation related decision-making is really decentralized. A further recommendation would therefore be to decentralize the decision authority effectively.

3.5.2 Limitations and Suggestions for Further Research

In this study, multiple sources of information were combined, while an iterative procedure was used in order to increase the internal validity of the constructs, and the extent to which the inferences from the cases correctly represent reality (Yin 1994). The purpose and scope of the present study were essentially exploratory. Based upon the researchers' observations, a number

of propositions were developed and integrated into a theoretical framework that should be refined and validated in further research. This research could for example consist of a cross sectional design, applied to a large sample of high-tech service innovation projects. Valid and reliable measurement instruments need to be developed for many of the constructs brought forward, such as ‘effective decision-making’ and ‘decision-maker expertise’, etc. These are complex and latent constructs that should be measured on many levels and in many dimensions.

The study revealed that decision-makers use various cognitive skills and decision styles in order to deal with the difficult conditions in their task. Very little is known, however, about the relative value and validity of the use of analysis, intuition and common sense under these conditions and in what sense or to what extent their effectiveness is moderated by expertise. Research is needed in order to determine how decision-makers adapt their cognitive style to the task conditions and order to develop a better understanding of the trade-off between ‘speed’ and ‘quality’ of various decision styles under real world conditions.

The study also revealed the important role of expertise as a moderator of decision-making effectiveness. The questions how expertise, in the present study conceptualized as decision-makers’ understanding of the four service-interfaces, originates and is maintained were considered beyond the scope of the present research. However, a major challenge for organizations in the telecommunication services industry, as well as in many other high-tech service industries, is the high turnover of staff in management functions. Since part of the expertise is tacit, the loss of experienced staff implies the loss of expertise and therefore the loss of an important competitive resource. We know exceedingly little about factors affecting the learning, maintenance

and transfer of expertise and knowledge in very turbulent environments. We suggest therefore that research be conducted in this area.

The scope of the research was limited in another sense. We focused on individual key decision-makers. However, decision-makers are part of an extensive information network and depend on external parties, such as the company's suppliers and retail outlets, for information about future developments and trends in technology and consumer behavior. It seems therefore worthwhile to study the decision-maker as a node in an information network that connects suppliers, developers, providers and customers. The adequacy of decisions and ultimately the performance of newly developed services will be dependent on the quality of the ties the decision-makers maintain in this network and the extent to which they manage such a network successfully (Burt 1992). We know very little about the precise structure of these networks. Therefore, the study of innovation decision-makers from a social networking perspective could help discover ways to optimize the network structure and efficiency by finding structural holes.

A limitation brought about by the design of the case research was the fact that we studied fully completed innovation projects, most of which had been achieved some time ago. Although it is understandable that companies active in the high-tech services industry are reluctant to share information about projects in progress, for obvious competitive reasons, it would be beneficial with respect to the study of decision-making to conduct longitudinal research over the full length of the innovation project. This would also permit the collection of less memory- and otherwise biased information, as we now, partially, had to rely on the representation of facts by the involved managers themselves.

Finally, an objective assessment of the performance of ICT-based service

development projects with respect to perceived quality and the creation of customer value requires the development of reliable and valid measurement instruments. Here, we can only repeat that the currently available service quality scales, developed for services where personal interaction between the provider and the consumer plays an important role, are not suitable for high-tech services (Bitner et al. 2000; Dabholkar 1996; Zeithaml et al. 2000). Research in this area must therefore be considered an absolute requirement for all further high-tech service research.

Chapter 4

Information: Effects on Choice and Commitment

This chapter is based on on a decision-making experiment. Professional decision-makers must currently assess and filter large amounts of real-time information for relevant cues. In previous research, limitations have been identified to the rationality with which managers make decisions under important uncertainty caused by *information scarcity*. The present study extends existing theories of bounded rationality for conditions of *information overload*. In order to obtain a more realistic and more complete representation of decision-making under uncertainty, we broaden the generally prevailing - narrow - conceptualization of decision-making as choice, and include decision-makers' development of initial commitment to the chosen course of action in the model. We demonstrate that spurious information, information that is - in a strict sense - irrelevant to the decision problem at hand, potentially affects a manager's initial commitment.

4.1 Introduction

Rapid technological developments in the recent past have led to an affluence of information. But more is not always better and the availability of more information does not necessarily seem to lead to better decision-making. This is substantiated in numerous reports about disastrous decision processes (Drummond 1998; Drummond 1994; Ghosh 1995; Keil et al. 1995; Keil and Montealegre 2000). Decision-makers are plagued by enormous amounts of information, much of it landing on their desktops via information systems like MIS, Enterprise Systems, e-mail, mobile devices and the World Wide Web. This information often contains cues to the solution of problems at hand, but it also contains much material that is, strictly speaking, not directly relevant. Especially in marketing and innovation management, the availability of large amounts of information creates serious processing challenges for decision-makers. Managers must continuously search and filter data for relevant cues and intelligently combine this information with their experience and expertise, in order to produce adequate decisions (Bucklin et al. 1998; Glazer 1993; Glazer et al. 1992; Wierenga and van Bruggen 1997; Wierenga and van Bruggen 2000). Decision-makers' processing difficulties increase as more information becomes available. It appears that information overload is becoming a more important source of uncertainty than information scarcity (Bucklin et al. 1998; Simon 1996).

Various categories of problems have been associated with decision-making under considerable uncertainty. Managers make biased decisions, take inappropriate risks or are irrationally committed to the implementation of their previous decisions (Bazerman 2001; Boulding et al. 1997; Clancy and Shulman 1991; Foxall 1984; Keil and Montealegre 2000). Problems in these categories seem to occur frequently, and often simultaneously, in innovation

(Schmidt and Calantone 1998) and new product marketing projects, where time pressure and high levels of complexity reinforce the problem of information affluence.

Not surprisingly therefore, theories of decision-making under uncertainty receive growing attention in marketing research (Lilien et al. 1998; Spence and Brucks 1997; van Bruggen et al. 1998; Wierenga and van Bruggen 1997; Wierenga et al. 1999) and research related to the innovation process (Bourgeois III and Eisenhardt 1988; Eisenhardt 1990; Leonard-Barton 1995).

4.1.1 Limitations to Previous Research

Behavioral decision research has extensively explored systematically occurring biases in decision-making under uncertainty and the bounds of managerial rationality in general (Kahneman et al. 1982; Simon 1997). In the light of current developments, however, limits to the theoretical scope of this research are becoming apparent, that restrict its explanatory power. A first limitation seems to result from a limited conceptualization of decision-making. Psychological or behavioral decision research (Barnard 1938; Cyert and March 1992; March and Simon 1993; Simon 1997), borrowed its conceptualization of decision-making in a basically unchanged form from economic decision theory (Schoemaker 1982; Von Neumann and Morgenstern 1947). In this tradition, decision-making has traditionally been represented as the selection or choice of a course of action that, up to a certain extent, is intended to maximize the decision-maker's utility (Schoemaker 1982).

This conceptualization takes into account only *one*, albeit important, output of the decision-making process, the *choice* or *selection* of a best or preferred decision option. The choice of a course of action that maximizes or satisfices (March and Simon 1993) utility, is not the only output of the

decision-making process, however. Managers estimate and evaluate risks and benefits of different options and make a choice on the one hand, but on the other hand they also develop a relatively stable affective state or attitude, often referred to as *commitment*, towards this course of action (Mintzberg 1979). We contend that the strength of commitment¹ to a chosen course of action is - at least partially - a result of conscious or subconscious mental processes and affected by information presented to the decision-maker.

Several categories of cognitive bias have been identified, occurring in judgments or choices made under uncertainty (Kahneman et al. 1982), that lead to decisions that violate theories of rational choice. Since the strength of managerial commitment to a decision can be considered an important determinant of the effectiveness of decision-making², it deserves to be investigated whether the strength of initial commitment could not be similarly affected in decisions made under uncertainty, e.g. caused by problems such as information overload. Notwithstanding the availability of a rich body of academic literature on the *process* of escalation of managerial commitment, the cognitive activities during decision-making, leading to the *development* of initial commitment, have been neglected. More specifically, there is a lack of research on the role *information* plays in the initial development of commitment. Therefore, it seems desirable to extend behavioral decision theories with research on the cognitive activities involved in the development of initial commitment.

¹With the term 'commitment' in this context we do not refer to what has been described in the literature as 'goal commitment' or 'organizational commitment'. Although commitment to the implementation of a decision can be considered to be related to or *embedded* in these broader forms of commitment, it is certainly not identical. We use the term to refer specifically to the attitude towards the choice made by the decision-maker.

²We refer to Chapter 2 for a definition of 'decision-making effectiveness'

Furthermore, with the exception of some research focusing on the use of managerial intuition (Blattberg and Hoch 1990; Glazer et al. 1992), much previous research has focused on the identification of mechanisms responsible for biases in judgments made under uncertainty caused by a *lack of information*, rather than an overload. Questions remain about the generalizability of the results for conditions of uncertainty arising from *information overload*. Combining these two research opportunities, the question guiding the present study becomes:

- *What are the effects of information on managerial judgment and initial commitment to a decision, under conditions of uncertainty caused by information overload?*

In order to address this research problem, we must deal with a number of related issues:

- RQ 1:** *Can we discriminate between choice and commitment as decision outputs?*
- RQ 2:** *Is there such a thing as rational commitment?*
- RQ 3:** *Which antecedents of commitment are affected by irrelevant information, especially under conditions of information overload?*
- RQ 4:** *Which antecedents of choice are affected by irrelevant information, especially under conditions of information overload?*

4.1.2 Contribution

As information overload is becoming a significant problem for managers, it is important to study its effects on all cognitive activities involved in the de-

cision process. Biased judgments, inappropriate risk behavior and escalation of commitment can each bring great risk to a company when they occur, and may be aggravated by information overload. The current conceptualization of decision-making explains these phenomena insufficiently. In this study we therefore intend to investigate the potential effects of various aspects of information on decisions made in an information-rich environment.

4.1.3 Approach and Structure of this Chapter

First, we must conceptually distinguish the two outputs of decision-making. We develop a framework that will form a basis for a number of propositions. Then we will present an experiment with a fair degree of contextual richness (Staw 1997), developed in order to test the propositions. In this experiment, the effects of relevant and irrelevant information on choice and the strength of initial commitment are tested, under conditions of substantial uncertainty caused by an affluence of information. We specifically consider effects of information that is not directly relevant to the decision problem at hand. We subsequently discuss the findings and present an overview of the limitations of the current study. Implications for further research and managerial practice are finally discussed.

4.2 Literature Review and Development of Propositions

Can the mental processes leading to the choice of a course of action on the one hand and the development of initial commitment to that choice on the other be separated? The two forms of output of the decision process can be

distinguished conceptually. This is demonstrated in the following example. Two managers, deciding about a new product marketing project, each provided with different information, may choose to implement the same course of action. One could initially be strongly committed to her decision, whereas the other may only feel weak initial commitment. For the company, this may ultimately lead to considerably different outcomes. The more strongly committed manager will, for example, react very differently upon receiving negative feedback regarding the progression of a project, than the manager who, for some reason or other, was less committed. This may lead to very different outcomes for the firm. Differences in the strength of initial commitment can lead to differences in the magnitude of *subsequent* resource allocations to a project, and therefore to various degrees of success.

Two managers could also reach different conclusions with respect to the magnitude of resource allocations, but still support their decisions with similar degrees of commitment. Again, two different situations arise, with different outcomes for the firm. This example substantiates that the output of a decision-process can be separated into a choice element and a commitment element. Relatively independent mental processes appear to be responsible for a choice on the one hand and for the formation of commitment to that choice on the other.

Disproportionally high, or nonrational (Bazerman 2001) commitment to a decision occurs, when continuous and abundant negative feedback about the progress of a project does not lead to its abandonment. Under certain circumstances managers ignore negative feedback about the success of projects. This type of undesirable managerial behavior (Bazerman 2001) has been conceptualized as an escalation of commitment (Staw 1981; Staw 1976). Too much commitment, or resistance to change, can be very harmful to the

interests of the company, as it may lead to continued investments in doomed projects (Drummond 1998; Drummond 1994)

We suggest calling commitment appropriate or rational, when decisions with respect to the continuation or withdrawal of a project are made in a rational way, i.e. when positive and negative feedback are both acknowledged and taken into account to the appropriate extent. Early abandonment – e.g. in the case of disappointing first results - of potentially very successful projects may result, if commitment is inappropriately low.

Most researchers see a strong link between cognitive limitations and sub-optimal choices of a course of action (Kahneman et al. 1982). So far, antecedents of (disproportionate) commitment have not been sought in biased mental processes, but rather in the psychological constitution of the manager. A number of project-related, psychological, organizational and structural explanations of escalation behavior have been proposed in escalation literature (Newman and Sabherwal 1996), but effects of bounded rationality in the processing of information on the development of commitment have, not yet been studied as such.

When choice and commitment indeed represent distinct and separable output elements of a decision, and result from distinguishable mental activities, it must also be possible to distinguish the antecedents of both dimensions. We therefore first propose:

Proposition 4.1 *Information presented to a decision-maker may have distinct effects on the choice of a course of action and on initial commitment to that choice.*

4.2.1 Choice

In order to identify effects of affluent information on decision-maker output, we first consider the ‘choice’ element. This is the element of the decision that has first been studied in depth in economically, or game-theoretically (Von Neumann and Morgenstern 1947) inspired decision research. In this tradition decision-making has been conceptualized as an intentionally rational (Simon 1997), informed choice between decision alternatives, generally with the purpose of maximizing expected utility (Schoemaker 1982). Inspired by the work of Barnard (1938), behavioral decision theory has taken into account a range of limitations to the rationality with which this choice is made (Kahneman et al. 1982; March and Simon 1993; Simon 1997; Simon 1987). Behavioral decision research has taken on the conceptualization of decision-making as choice. Research in this tradition was therefore limited to the identification and study of factors causing a bias in the rationality of the choice or judgment component of the decision. In this tradition a decision is considered biased to the extent that the actually chosen solution deviates from the choice that would have resulted from an entirely rational calculation under conditions of perfect information (Bazerman 2001). In managerial practice, it is argued, even if decision makers try to make substantively rational decisions (March and Simon 1993), they can only do so within certain boundaries, imposed by limits upon the availability and quality of information, the way the human cognitive system functions and the extent to which decision-makers are embedded in a social structure (Simon 1957). Managerial or indeed human judgments and the resulting decisions suffer from bounded rationality under specific conditions and due to a number of factors. Here a discussion of conditions and factors that are related to information and information processing is presented.

4.2.2 Causes of Bias

Bias in judgments occurs in part because managers never have access to perfect or complete information. At the same time, managerial problems are very complex, whereas humans have a limited amount of attention and can therefore only deal successfully with problems of limited complexity. Furthermore, especially in managerial decision-making, most decisions are made under time pressure. Imperfect information, problem complexity and time pressure³ have generally been identified as conditions under which biases in judgments are likely to occur (Bazerman 2001; Kahneman et al. 1982; Simon 1997).

Three types of bias have been identified. In the first place, it has been proposed that in order to deal with insufficient information, complexity, and time pressure managers use heuristics or shortcuts (Tversky and Kahneman 1974). Heuristics do not always lead to unbiased or substantially rational results, due to limitations in our capability to make proper statistical calculations (Bazerman 2001; Kahneman et al. 1982). Second, it has been proposed that due to the fact that fast, intuitive, or non-explicit cognitive processes are involved biasing effects can be expected from strong emotions (Simon 1987). March and Simon (1993) have identified a third factor affecting the substantive rationality of judgments. They made the observation that managers often ‘satisfice’ under time and organizational pressure, i.e. they do not necessarily look for optimal solutions when making a decision, but rather go for a solution that is acceptable under the given circumstances (March and Simon 1993). In other words, decision-makers do not consider all possible options, but tend to stop looking for better alternatives, once they

³These are the task conditions identified in the case study presented in Chapter 3, which innovation managers consider to affect their decision-making effectiveness negatively

have found a course of action that satisfies certain predetermined minimum requirements.

4.2.3 Decision Making as Resource Allocation

Managers choose their actions in order to maximize (Schoemaker 1982) or satisfice (Simon 1997) expected utility, with respect to certain predetermined objectives. For managers the majority of decisions concern the allocation of scarce company resources. The objectives of such decisions could be to reach previously established sales targets, profitability targets, growth rates or most probably a combination of these. Within the limits suggested by theories about bounded rationality, marketing managers are generally assumed to be economic actors and therefore choose to distribute their scarce resources over different projects with the purpose of maximizing or at least satisficing expected utility. In order to make decisions managers select and consider information that is relevant to the decision problem. It was found that more experienced managers distinguish rapidly between information that is relevant for the problem at hand and information that is not (Perkins and Rao 1990). This implies that managers ignore part of the available information, the part that appears irrelevant. In order to judge certain information to be irrelevant they first have to consider it, however. Does information that is appropriately considered irrelevant and ignored by experienced managers not have an effect upon the decision at all, for example when it affects the decision-maker in other respects than in the direct context of the decision problem? Does it not play a role at all in the decision-process?

Consider the decision process in a resource allocation decision. Before a manager can decide about the allocation of scarce resources to a project, he must develop performance expectations for that project, with respect to

the risks and benefits for the company and himself. These expectations will largely be based on information about the project. The mental representation of the project and its potential outcomes will be the result of the selection and processing of information about the project and the company in an ongoing sensemaking process (Weick 1995). According to the aforementioned decision theories, the amount of resources allocated to a project will be relative to the utility the manager expects to derive from the project, corrected for the estimated chances of success of that project (Smidts 1997). Although managerial expectations as such may well be biased (Kahneman et al. 1982; Simon 1997), all decision theories would predict a strong relationship between performance expectations reported by managers and their subsequent resource allocations. We therefore expect:

Proposition 4.2 *There will be a strong positive relationship between expected utility of a project, formed on the basis of relevant information, and the subsequently chosen allocation of scarce resources to that project.*

Based on theories and research about intuitive and heuristic judgments (Kahneman et al. 1982; Simon 1957), it has been proposed that two relatively independent information-processing systems coexist in the human mind: a rational-analytical, conscious and explicit information processing mode and an experiential or intuitive mode (Denes-Raj and Epstein 1994; Epstein et al. 1992; Teglas and Epstein 1998)⁴. Under conditions characterized by moderate levels of uncertainty, time pressure and complexity, an explicit information-processing mode prevails. Under these circumstances managers dispose of sufficient time and attention to make their assumptions explicit, conduct market studies and deliberately select an advantageous course of

⁴See Chapter 2 for a detailed discussion.

action. It has been suggested that decisions and judgments made under conditions of time pressure, high complexity, information inadequacy and therefore substantial uncertainty involve other than strictly rational information processing modes (Agor 1986; Brockmann and Simmonds 1997; Eisenhardt 1990; Perkins and Rao 1990). Marketing decision-making often occurs under conditions of extreme time pressure, complexity and uncertainty. Sometimes hundreds of product-market decisions have to be made in a very short time span, leaving little time for explicit reflection, let alone market research. Under these circumstances it can be expected that managers, at least partially, use the intuitive, more synthetic or experiential information-processing system, which is characterized by its relative speed, the direct use of previous experience in the form of pattern recognition and readily available decision premises (Weick 2001). There are indications that rapidly made complex judgments and decisions that involve the use of intuitive reasoning are prone to influences from strong emotion caused by non-relevant information (Forgas and Moylan 1988). In the case of a manager deciding about the allocation of company resources, these emotions could well be caused by precisely the information decision-makers consider to be irrelevant to the problem at hand. We therefore expect that irrelevant information causing positive or negative emotions in the decision-maker will affect the formation of performance expectations, if this takes place under conditions of great uncertainty caused by information overload and time pressure. In the context of a product manager making decisions based upon his expectations, this would lead to biased (either too low or too high) allocations. We therefore expect:

Proposition 4.3 *Under conditions of uncertainty caused by an affluence of information, performance expectations of a decision-maker will be affected by emotionally laden information that is irrelevant to the decision problem.*

More precisely:

Proposition 4.4 *When information, that is not directly relevant to the problem under consideration, but which has a positive (negative) effect upon the decision-maker's emotional state, is presented together with relevant information, managers will optimistically (pessimistically) adjust their (performance) expectations.*

4.2.4 Commitment to a Chosen Course of Action

In environments characterized by dynamic interactive complexity (Weick 1990), decisions that are substantially rational at the moment they are made, may still lead to wrong and even fatal outcomes, if disproportionate commitment to the decision is preventing managers from acknowledging information that should lead to adjustments later on in the project. The problem of escalation of commitment seems to occur often in new product development projects, projects involving information technology, and other projects surrounded by much uncertainty (Drummond 1998; Drummond 1994; Keil and Montealegre 2000; Schmidt and Calantone 1998; Staw 1981). In spite of persuasive negative feedback, managers often remain committed to the implementation of their decisions, apparently choosing to ignore this information. This implies that in some situations initial managerial commitment to the implementation of a decision is not affected by new information that is relevant to the decision. This in turn implies that initial managerial commitment is an important decision output, and that we have to look for the antecedents of initial commitment, if we want to understand escalation behavior better.

Antecedents of managerial commitment, especially goal commitment, have been studied in organizational research, particularly in the context of motivation (DeShon and Landis 1997; Hollenbeck et al. 1989). In analogy to

a commonly used definition of commitment (Williams and Hazer 1986) we may define managerial commitment *to a decision* positively as engagement (Kahn 1990) or as an attitude expressing willingness to expend (more) effort in the future, in order to reach the objectives of the decision. This attitude is generally positively valued in a manager. On the other hand, commitment can also, in a negative sense, be framed as the unwillingness to change one's mind about a decision, once it is made (Bazerman 2001). This is the type of attitude that causes nonrational escalations of commitment. According to expectancy theory (Vroom 1964), the strength of managerial engagement or commitment to a chosen course of action is determined by extrinsically and intrinsically motivating factors that make the achievement of objectives desirable. Extrinsic motivation to be committed to a decision will by definition be generated by information that is relevant to the decision at hand, e.g. the size of the remuneration that is awarded in case of success. Relevant information, inducing certain expectations with respect to the performance of a new product, will have an effect on the decision-maker's extrinsic motivation. Therefore we expect:

Proposition 4.5 *When a new product is announced, performance expectations with respect to that new product will affect a manager's commitment to a decision to allocate resources to the marketing of that product.*

Intrinsic motivation, and self-confidence on the other hand, may be affected by information that is not necessarily related to the decision problem, but that relates to the wider context of the company, the industry or the working environment. We therefore expect information that affects the overall attitude of the decision-maker towards their working environment, to affect commitment to decisions made within the context of that company. The over-

all attitude of the decision-maker towards his working environment shows in his morale. We therefore propose:

Proposition 4.6 *Information that influences a manager's overall attitude towards the professional environment, or morale, through effects on intrinsic motivation or self-confidence, will affect managerial commitment to a decision even when the information itself is irrelevant to the decision problem.*

More precisely:

Proposition 4.7 *Information that influences morale positively (negatively) affects managerial commitment to a decision positively (negatively).*

4.2.5 Perceived Information Quality

A factor that may directly or indirectly influence a decision-maker's attitude towards his choice of a specific course of action could be his confidence in the substantive rationality of that choice. In other words, decision-makers' confidence in the rationality of a decision will probably affect their commitment to that choice. The certainty, with which a manager makes a choice, or his confidence in the quality of his choices, is influenced by his perception of the quality of the information he is using. When a manager perceives the quality of the available information to be bad, e.g. if it contains insufficient cues, he will perceive a higher degree of uncertainty. Although he would still make the decision to the best of his ability, it would make him feel less confident with respect to the rationality of his decision. Conversely, the extent to which a manager perceives the information upon which he bases his decisions as complete will positively impact his confidence in the appropriateness of his decisions. We therefore expect there to be a positive relationship between the

perceived quality of the available information and the resulting commitment to the decision. We propose:

Proposition 4.8 *Perceived quality of the information used in a decision will have a positive effect on managerial commitment to that decision.*

On the other hand, we expect that personality characteristics of the decision-maker, in particular risk attitude, will moderate the effect of perceived information quality on commitment. Risk-averse managers are more cautious, and therefore more open to adapt their subsequent choices to feedback. We therefore expect them to develop a lower level of initial commitment to projects that are perceived as risky, such as the allocation of company resources to the introduction and marketing of highly innovative products. We therefore expect a direct effect of the level of risk-aversion on commitment and propose:

Proposition 4.9 *There will be a direct relationship between the risk attitude of the decision-maker and the level of commitment to a resource allocation decision pertaining to a project perceived as risky.*

If the decision-maker has the impression that the quality of available information is low, or the reliability of the source is not certain, he or she will be even less certain about the chances that the project will succeed. This will affect a risk-averse manager more than a risk-neutral colleague. In addition we therefore propose:

Proposition 4.10 *The effect of perceived information quality on commitment will be moderated by the risk attitude of the decision-maker.*

The proposed relationships between constructs are summarized and graphically represented by the model in Figure 4.1.

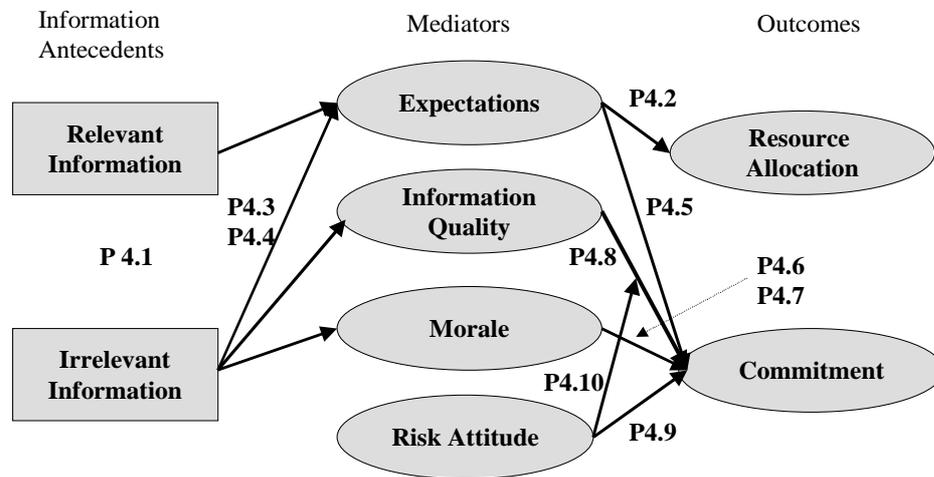


Figure 4.1: Antecedents and Mediators of Decision Outcomes

4.3 Research Design and Measurement

We chose to test the propositions in a controlled experimental setting. We decided to study the relationships between information, morale, choice, and commitment in the context of new product marketing⁵ and designed a realistic marketing decision-making simulation. For the duration of the experiment, participants were asked to assume the role of a Marketing Manager. They were provided with abundant information and had to make resource allocation decisions with respect to the introduction of an innovative product in their market.

The sample consisted of ninety fourth-year business administration students, enrolled in an advanced course in marketing decision-making at a medium-sized European university. Individual participants studied various

⁵There are a number of reasons for this choice. Although much marketing decision-making can and will be automated in the future, *new product marketing* related decision-making remains an exception, in the sense that managerial skills will continue to play an important role in this domain. This is due to the fact that a global and ever more dynamic marketplace is making consumption trends increasingly difficult to predict in most industries, especially so with respect to highly innovative products that are either entirely new to the market or to the organization. In such cases no useful experience is available with respect to the organization of business processes, as these innovations have little in common with previously carried products. Therefore it is difficult to make structured use of data available with respect to other products. Dealing with large amounts of unstructured information is therefore required. Second, the need for quick decisions in the case of innovative products in highly competitive markets often does not allow time for any structured data collection process and a rigorous analysis. New product marketing related decisions will therefore continue to depend largely on the human skill to process large amounts of information quickly in order to solve often very complex decision problems.

information packages and then filled out a questionnaire. The experiment lasted for approximately one hour.

4.3.1 Description of the Experiment

After we explained the procedure of the experiment in detail, we provided all participants with a detailed job description of the marketing manager they were supposed to impersonate. Participants were asked to adopt the role of a regional marketing manager in a globally operating educational publishing company. Subsequently we distributed a second, more extensive information package.⁶ This second package contained abundant and very detailed information about the company employing them, the product range they had responsibilities for, the complexities of the market and the political, competitive and technological environment etc. This information package also explained whereof their assignment consisted: They would have to decide about the allocation of scarce company resources to the marketing and distribution of a really new product. This product, a web-based educational tool was entirely new both to the market and to the company. The information package contained a fact sheet about the new product, providing them with abundant technical and marketing details. After having been allowed to study the information package for ten minutes, the participants received five pages of printed e-mail messages, addressed to the manager they impersonated. These e-mail messages originated from different senior managers and secretaries inside and outside their company and contained information that was strictly speaking irrelevant to the new product marketing problem, but had to do with events organized by the company and corporate decisions about alliances, divestures etc. These messages were intended to reflect

⁶The information package is included in the Appendix at the end of this dissertation.

the average mail a marketing manager may receive on a typical day. We produced two distinct sets of e-mail messages. The messages in one set contained information that was meant to induce a positive overall disposition in the participants. The messages in the other set were meant to have the opposite effect. For samples of the messages that were distributed to the participants we refer to Table 4.1.

Table 4.1: Examples of Colored Information

Sample of Negative e-mail:	Sample of Positive e-mail:
The Annual Company Ball that was due on Hawaii in September will be cancelled. You will receive more information soon.	The Annual Company Ball in September will not be organized in the Phoenix Hilton, as has been the case in the past, but instead will take place on Hawaii! Hope to see you all in that splendid location! Bring your dancing shoes!
Your order for a new chair for your office has not been approved. Our financial director gave no further explanation for the refusal. Would you be so kind as to send me an overview of the other office materials you and your staff will need for the upcoming two months.	The order for a new chair for your office has been approved. The chair will be shipped to you next week. Great design you chose! Would you be so kind as to send me an overview of the other office materials you and your staff will need for the upcoming two months.

Table 4.1: *continued*

Sample of Negative e-mail:	Sample of Positive e-mail:
<p>The sick trees in front of your office will be cut down. The deed will be done next Friday. There will be inconvenience caused by the noise. I have ordered the engineering department to install a sunscreen to all offices on your side of the building, as the sun will plague you without the trees. The works will only start next month. I hope the inconvenience will be limited.</p>	<p>The sick trees in front of your office will be cut down. The deed will be done next Friday. In order to limit the inconvenience caused by the noise I grant all staff in your office a day off. Make the best out of it!</p>
<p>As a consequence of the restructuring of our domestic Sales force we have decided to reduce the duration of the National Sales Meeting from ten to five days. You will receive an updated program soon.</p>	<p>In response to the publication of very favorable first quarter sales figures, we have decided to increase the duration of the National Sales Meeting from ten to twelve days. You will receive an extended and updated program. We are pleased to announce an additional two-day company tour to the Grand Canyon, to reward you for your hard work.</p>

In total, fifty copies of the negative sets and forty of the positive sets were distributed at random over the participants. By explicitly announcing that the information packages would be taken away from the participants within ten minutes, we imposed a fair amount of time pressure on the participants, with respect to the processing of the information.

4.3.2 Data Collection

After gathering the information packages back from the participants we distributed a questionnaire. This questionnaire consisted of two parts. The first part contained questions related to the assignment. The second part contained questions with respect to the participants' perceptions of the described situation and perceived cognitive requirements of the assignment.

4.3.2.1 The Assignment

In the first part of the questionnaire the participants were required to indicate how well they expected the hypothetical new product to perform in a number of different dimensions. Subsequently, they were asked to indicate to which extent they would allocate a variety of scarce company resources to the introduction of the really new educational product in the territory assigned to them. Finally, they had to indicate how strongly they were committed to their resource allocation decisions.

4.3.2.2 Background Information

In the second part of the questionnaire we asked the participants about their attitude towards the job, the company, and the business. In this way we wanted to measure their general disposition or morale. Furthermore we asked them to report their perception of the quality of the provided information.

All responses were measured as self reported attitudes towards a number of statements. We asked the participants to indicate the extent to which they agreed with these statements on seven item Likert scales.

4.3.3 Operationalization of the Model

The first variable that needed to be measured was ‘performance expectations’. We interpreted performance expectations as a complex and latent construct, and produced a number of indicators, each measuring expectations in a different performance dimension. We followed a similar procedure for ‘resource allocation’. Again a number of indicators were constructed, measuring resource allocations in a number of fields, such as training of the sales force, marketing and distribution.

We measured decision-maker’s ‘commitment’ to the chosen course of action by slightly adapting the indicators proposed by Hollenbeck et al. (1989) and reduced and refined by DeShon and Landis (1997), as it was found that the original commitment scale defined by Hollenbeck et al. (1989) actually confused performance expectancies and goal commitment. We decided to start with the adapted scale proposed by DeShon and Landis (1997) and adapt the indicators further, in order to measure commitment to the decision, rather than commitment to the organization, for which the indicators were originally intended.

The next important variable we needed to measure was ‘morale’, which we have defined as an information-induced overall disposition of the participant towards their job and the company. As we did not find any existing measurement instrument for this variable, it was decided to measure it as the extent to which decision-makers agreed with a number of statements about their overall attitude towards the company and the assumed job.

We also wanted to measure the participant’s overall perception of the quality of the information we had provided them with. Questions about the perceived level of ambiguity, the extent to which the information was observed as confusing and the ease with which the decision-maker could judge

the presented information for relevance were therefore included, in order to measure this latent construct.

Finally we measured the ‘risk attitude’ of the decision-makers. No validated measurement instruments were available in the literature for this type of overall managerial risk attitude. We therefore designed a simple instrument using three indicators, one measuring risk attitude with respect to the new product decision under consideration and two measuring more generally the personal risk attitude of the decision-maker. The results of a confirmatory factor analysis performed in Lisrel are reported in Table 4.2. In this table we present the items used and their loadings on the three factors, as well as the internal consistency of the factors as expressed in Cronbach’s alpha.

4.4 Data Analysis, Findings and Discussion

We ended up with eighty-four completed questionnaires. A number of respondents left early, or did not fill in all questions. Participants having received negative e-mails submitted forty-eight questionnaires and participants having received positive e-mails thirty-six. In order to reduce the number of variables we performed a number of factor analyses on limited subsets. One factor analysis was carried out on the explanatory variables of the experiment: ‘performance expectations’, ‘perceived information quality’ and ‘morale’.

In the indicators that were intended to measure ‘performance expectations’ we found two factors (using the common cut-off value of ‘1’ for the Eigenvalues) in a principal component analysis, which we interpreted as ‘short-term expectations’ and ‘long-term expectations’. Items and factor loadings obtained in a confirmatory factor analysis, obtained in Lisrel, are

Item	Morale	Risk At- titude	Information Quality
Reliability:	$\alpha=.88$	$\alpha=.74$	$\alpha=.63$
Would Take Risks	–	.64	–
Taking Risks Professionally	–	.88	–
It is a Good Attitude to Take Risks	–	.89	–
Love to Work for Company	.89	–	–
Love to Work in Position	.85	–	–
Have Good Feeling about Com- pany	.79	–	–
Have Good Feeling about Job	.87	–	–
Information was not Confusing	–	–	.79
Information Easy to Judge for Relevance	–	–	.62
Information was not Ambiguous	–	–	.79

Table 4.2: Measurement Analysis: Independent Variables

Item	Short-term Expectations	Long-term Expectations
Reliability:	$\alpha=.85$	$\alpha=.70$
Increases Financial Performance	.83	–
Increases Commercial Performance	.83	–
Improves Reputation & Brand Equity	.83	–
Improves Customer Satisfaction	.83	–
Market Develops Positively	.83	–
Optimistic about Success	.84	–
New Product will be a Success	.81	–
Create Opportunities for Other Innovations	–	.83
Create Opportunities for Differentiation	–	.82

Table 4.3: Measurement Analysis: Independent Variables Continued

reported in Table 4.3. The data showed a reasonable fit to our two-factor model. We obtained the following fit values: χ^2 : 19.42, P: 0.15, AGFI: 0.87 and RMSEA: 0.062. The internal consistency of the factors as expressed in Cronbach's alpha is also reported in this table.

Subsequently, we performed a confirmatory factor analysis on the explained variables of the research, being 'resource allocation' and 'commitment'. Results of this factor analysis are presented in Table 4.4. Again the data showed a reasonable fit to the two-factor model. We obtained the following fit values: χ^2 : 45.12, P: .077, AGFI: 0.86 and RMSEA: .060. The internal consistency of the factors as expressed in Cronbach's alpha is also reported in this table.

Item	Resource Allocation	Commitment
Reliability:	$\alpha=.76$	$\alpha=.75$
Will allocate Financial Resources	.55	–
Will allocate Human Resources	.54	–
Will allocate Managerial Resources	.78	–
Will allocate Technical Resources	.52	–
Will allocate Marketing Resources	.72	–
Will allocate Logistical Resources	.65	–
Am strongly Committed to Decisions	–	.38
Believe I am Right about Decisions	–	.44
Would strongly Defend Decisions	–	.87
Difficult to Change my Mind	–	.79

Table 4.4: Measurement Analysis: Dependent Variables

	ResAll	LtExp	StExp	Comm	Morale	InfQual
ResAll	1					
LtExp	.277**	1				
StExp	.544**	.141*	1			
Comm	.291**	.95	.302**	1		
Morale	.176	-.145	.306**	.303**	1	
InfQual	.184	.064	.384*	.456**	.321**	1
RiskAtt	.272**	.265**	.296**	.425**	.027	.162

** . Correlation significant at the 0.01 level (2-tailed)

* . Correlation significant at the 0.05 level (2-tailed)

Table 4.5: Pearson Correlation between Main Constructs

Based upon the results of these factor analyses, it was decided to compose the main constructs as averages of the scores for the components. In order to explore the data a correlation table was constructed, containing all core constructs. Correlation coefficients between the core-constructs are presented in Table 4.5.

We posited the ‘morale’ construct as a mediator between irrelevant information, decision-maker’s expectations and the decision outcomes. A first concern was to establish whether the two different sets of e-mail packages had indeed had distinctive effects upon the morale of the participants. A dummy variable with two values was constructed. In order to test the effects, a one-way ANOVA was performed on ‘morale’. From this analysis it has become clear that the two groups had reported significantly different overall attitudes towards their company and job. For the results we refer to Table 4.6. Those having received positive e-mails had clearly a much more cheer-

Dependent		Mean Square	F	Sig.
Morale	Between Groups	23.583	32.547	.000
	Within Groups	.725		
LtExp	Between Groups	.084	.083	.774
	Within Groups	1.011		
StExp	Between Groups	.190	.188	.666
	Within Groups	1.010		

Table 4.6: Manipulation Test (ANOVA)

ful disposition towards their job and employer, than those having received negative e-mails.

In order to investigate the proposition that under conditions of information overload and time pressure decision-maker's expectations would be influenced by the affective content of irrelevant information, another ANOVA was performed with the same dummy, but now on 'short-term expectations' and 'long-term expectations'. The results of this ANOVA analysis are also presented in Table 4.6.

From this table it is clear that the manipulation of the irrelevant information, though having a significant effect upon the participants' morale, does not affect their performance expectations. The data do therefore not provide support for the proposition that emotions affect performance expectations formed under information overload and time pressure (Propositions **P**_{4.3} and **P**_{4.4}).

The next objective was to test the predicted relationships between the various dependent and independent variables. A MANCOVA analysis was performed, which included all explanatory variables, 'long-term expectations'

Source	Dependent Variable	F	Sig.
Corrected Model	ResAll ^a	10.297	.000
	Commitment ^b	11.160	.000
Intercept	ResAll	12.081	.001
	Commitment	3.595	.061
StExp	ResAll	26.773	.000
	Commitment	.011	.917
LtExp	ResAll	5.266	.024
	Commitment	.001	.974
Morale	ResAll	.591	.444
	Commitment	4.187	.043
InfQual	ResAll	.328	.568
	Commitment	13.732	.000
RiskAtt	ResAll	.822	.367
	Commitment	17.173	.000

a. R Squared = .347 (Adjusted R Squared = .313)

b. R Squared = .365 (Adjusted R Squared = .332)

Table 4.7: Mancova on the Dependent Variables

(Lt-Exp), ‘short-term expectations’ (St-Exp), and ‘morale’ as covariates. The constructs ‘resource allocation’ (ResAll) and ‘commitment’ were included as dependent variables. We included ‘risk attitude’ (RiskAtt) as a control variable. The results of the analysis are presented in Table 4.7.

Table 4.7 shows that variance in ‘short-term performance expectations’ appears to be responsible for a substantial part of the variance in ‘resource allocation’, whereas long-term performance expectations have a considerably weaker, but significant (at 10% level) effect. We expressed this in our propo-

sition $\mathbf{P}_{4.2}$, which is therefore supported. No other independent variable was significantly related to 'resource allocation'. Therefore propositions $\mathbf{P}_{4.3}$ and $\mathbf{P}_{4.4}$ are not supported by the data. However, this could be explained by the possibility that the experimental conditions did not sufficiently simulate the effects of time pressure or complexity on the decision-makers, in order to make this effect visible.

We expected a positive effect of relevant information on commitment, through the extrinsically motivating effect of performance expectations. This proposition, $\mathbf{P}_{4.5}$, is partially supported by the data: In Table 4.5 it can be seen, that significant correlation only exists between 'short-term expectations' and 'commitment'. This could be explained by the absence of explicit information about long-term remuneration or bonus-schemes. Apparently the participants, no business decision-makers, did make a link between expected product performance and the size of their rewards.

At the same time it becomes clear that the three other independent variables 'morale', 'information quality' and 'risk attitude' largely explain the variance in the other dependent variable 'commitment' (adjusted $R^2 = .33$). The effect of morale on intrinsic motivation was expected to be reflected in the strength of commitment, as expressed in $\mathbf{P}_{4.6}$ and $\mathbf{P}_{4.7}$. These propositions are both supported at a .05 significance level: there is an undeniable effect of 'morale' on 'commitment'.

To test the effects of information quality and risk attitude on commitment, a multiple regression analysis was conducted. The results of this analysis are presented in Table 4.8.

The proposition positing a direct positive effect of perceived information quality on commitment, $\mathbf{P}_{4.8}$ is supported by the data. A strong direct effect of Risk Attitude on commitment was also found, as proposed by $\mathbf{P}_{4.9}$.

Independent	B	Std. Error	Beta	t	Sig.
Constant	1.217	.494		2.466	.015
Inf. Quality	.367	.093	.338	3.927	.000
Risk Att.	.299	.067	.365	4.480	.000
Morale	.129	.059	.185	2.175	.032
Risk * Inf.	.003	.075	-.037	-.464	.644

F=14.173 Sig.= .000 Adj. R²= .341

Table 4.8: Regression on Commitment

The mediation of the effect of information quality on commitment by the participant's risk attitude, as posited by $\mathbf{P}_{4.10}$, is not supported by the data. To avoid problems caused by high levels of multicollinearity between the components of the interaction term and the term itself, the interaction term was not directly included in the regression equation. Instead we included the residuals of a second order regression, performed according to the residual centering method proposed by Lance (1988).

Intriguing and most important finding of the present study is the fact that antecedents of the two decision outcome variables are distinct and even mutually exclusive. This provides more support for the proposition $\mathbf{P}_{4.1}$, that commitment is not formed based upon the same aspects of information as preference or choice. An overview of the results is presented in Table 4.9.

4.5 Conclusion

The most important outcome of the present study is that significant effects have been demonstrated of perceived information quality, non-relevant information (information that has no direct relevance to the decision problem)

Nr.	Description	Result
P 4.1	Commitment and Choice have Distinct Antecedents	✓
P 4.2	Performance Expectations are Antecedents of Resource Allocation	✓
P 4.3 P 4.4	Irrelevant Information affects Resource Allocation under Overload Conditions	–
P 4.5	Performance Expectations affect Commitment	(✓)*
P 4.6 P 4.7	Morale affects Commitment under Overload Conditions	✓
P 4.8	Perceived Information Quality affects Commitment	✓
P 4.9	Decision Maker's Risk Attitude directly affects Commitment to a Risky Project	✓
P 4.10	Risk Aversion mediates the Effect of Information Quality on Commitment	–

*Partially supported: only for Short-Term Expectations

Table 4.9: Overview of the Propositions

and risk attitude on reported initial commitment. This implies that information processing does play a role in the development of commitment, justifying more research into cognitive biases with respect to commitment. We explained the effect of irrelevant information by the effects this type of information may have on the intrinsic motivation, via the morale of the decision-maker. Whereas commitment traditionally has been conceived as a relatively stable state, explained by referring to economic, psychological or organizational mechanisms, a direct effect of information and information quality on commitment had never been considered. In our study it has become clear that information can play an important role with respect to both aspects of the decision, whereas different aspects of information are responsible for the effects on each outcome of the decision. The experiment seems to confirm that decision-makers indeed select relevant information and process this selection in order to establish rational expectations with respect to the potential success of a project. Looking at the negligible effect of the irrelevant information on the formation of their expectations, the participants indeed distinguished quite well between information relevant to the decision problem and information that was not. Consequently they also base their allocation of scarce resources to the project on these expectations, making this part of the decision rational as well. There was a fairly linear relationship between those expectations and the level of their resource allocations and no sign that the resource allocation, i.e. the choice aspect of the decision, was significantly biased by their morale or by affective components of the irrelevant information they received. We therefore conclude that, to a substantial extent, resource allocations are based on information relevant to the decision problem at hand.

The affective component of information that is not directly relevant to

the decision-problem appears to play a role in the process of developing commitment to the decision, through its influence on decision-maker's morale and intrinsic motivation. We did not find indications that performance expectations have a significant effect on decision-makers' initial commitment to the project.

The perceived quality of the information used in the decision-making process plays an important role in the development of initial commitment, whereas it does not affect performance expectations. Perceived reliability and clarity of the information provided to the decision-maker, and therefore the extent to which decision-makers trust and rely on their sources, apparently has a considerable effect on their initial commitment and therefore possibly on their unwillingness to admit and reverse 'wrong' decisions in a later stage.

4.5.1 Managerial Implications

Bias in the strength of initial commitment, like other cognitive bias, may prove to be difficult to avoid entirely. However, the awareness that matters not strictly relevant to the actual decision problem could influence the strength of initial commitment to a decision, should contribute to better decision-making. When making subsequent decisions with respect to the continuation or discontinuation of innovation projects or with respect to renewed investments, commitment to the initial decisions should be reconsidered and not taken for granted. Knowing what we know now, did we make the right decisions at the time and what should our attitude to the project have been? An awareness of the morale at the time of the decision could certainly make commitment to the decision more independent from that morale and therefore more rational.

Another managerial implication of these findings could be, that it is ex-

tremely important to retrospectively check the quality and reliability of information used during the initial decisions and its sources when making new investment decisions. An attitude that could act as a safeguard against inappropriate levels of commitment could again be not to take the initial decisions for granted, when making further investment decisions, but to be prepared to reconsider them while being aware of company morale at the time of that initial decision and the quality of information used.

4.5.2 Limitations and Suggestions for Further Research

We still possess little substantial knowledge about managerial decision-making in an organizational environment that is characterized by high velocity, information overload and much ambiguity. We are aware that the present study has only lifted a corner of the veil and probably created more questions than it attempted to answer. Although we think we found some thought provoking and rather substantial results, a number of limitations prevent us from directly generalizing the results to professional decision-making in an organizational environment. In the first place, although we did present ample information about the involved firm and its environment, making decisions solely based upon provided information about an organization, its products and its environment is very probably not the same as making product decisions in a real organization.

In the second place there is our choice of a student sample. On the one hand, although the students are trained and interested in decision-making and have a general understanding of business decision situations, they obviously do not have much decision-making experience.⁷ This could entail that

⁷In Chapter 3 we have observed that experience in decision-making, although it was considered not to affect the quality (the choice) of the decisions substantially, will affect

under conditions of time pressure they might be stronger influenced by irrelevant information than practicing managerial decision-makers. On the other hand, however, practicing managers would probably react much stronger to affectively colored information than our independent decision-makers, since this affectively colored information would concern their daily professional environment. If we want to generalize the results to managerial activities, the research must be extended to case studies of practicing product managers, in order to study the incidence, strength and durability of the effects.

Further research could also focus on the moderating effect of other conditions. In our experiment we only varied the *affective content of the irrelevant information*. The conditions under which the decisions were made, such as time pressure, complexity, information quality and information availability, were not moderated. In order to develop a better understanding of the cognitive phenomena that play a role, and the precise conditions under which biases in choices and disproportionate commitment start playing a role, we suggest that in further research those conditions should be varied and brought up to levels that compare with reality.

What we did not study is how persistent the initially reached level of commitment to a decision is, if that decision is made under conditions of substantial uncertainty. Does the level of commitment remain stable, after the decision has been made? It is important to know this, since this will determine if and when disproportionate initial commitment can really become a problem. The question rises if and how cognitive, personality, or organization related factors affect the persistence of disproportionate commitment. Are there conditions that affect the extent to which information about the speed of decision-making and the ability to make decisions effectively under difficult conditions.

failure of a project is being taken seriously? In further research attention should be paid to the temporal development of commitment, and commitment should be measured at different points in time after the decision, under variable conditions. This could be done by measuring the willingness of the decision-maker to reconsider initial decisions and by measuring the amounts of resources allocated at later points in time, while varying the affective quality of relevant (e.g. about failure) and irrelevant information administered.

Chapter 5

The Role of Information in High Tech Service Innovation Success

This chapter is based on a study exploring success factors in ICT-based service innovation. Success is associated with more effective decision-making during the innovation process, as a consequence of the reduction of uncertainty. Effects of inter-firm differences in organizational information gathering, diffusion and utilization are investigated on a strategic as well as on an operational level. Data were collected concerning 251 high-tech service innovations from companies in Europe, the US and Japan. Findings reveal the important role of a long-term strategic vision, and an organizational climate that is favorable to innovation. This climate mediates the effects of organizational intelligence efforts. Experience in the industry does not seem to play a major role in this turbulent business, but a regular updating of decision-makers, and the degree to which information is shared informally in the organization, are found to matter significantly.

5.1 Introduction

Information and communication technology (ICT) based services contribute increasingly to the growth of the global economy. Revolutionary technological developments of the past decennia have created innumerable opportunities for service innovation and new ICT-based services potentially create significant value for the provider as well as for the users of the services (Van den Ende and Wijnberg 2001). However, as a result of the tremendous speed of technological developments and the related globalization of markets, most providers of ICT-based services currently experience hyper-competition and exceptional turbulence in their marketplace (Bogner and Barr 2000; D'Aveni 1995; D'Aveni 1994). Increasingly short product life cycles are the result, implying an urgent need for continuous, effective and rapid innovation (Lehmann 1997). At the same time, turbulence, complexity and uncertainty in the macro environment of firms have turned high-tech service innovation into a very risky matter. Substantial investments are needed for the development of ICT-based services, while failure rates are high. As a consequence, it has become imperative for firms to improve the performance of their new service development processes and increase success rates (Boulding et al. 1997).

Over the past decades, a steadily growing stream of academic research attempting to identify innovation success factors has emerged. These studies have contributed a great deal to our knowledge. Success factors have been identified in the fit between the new product and the existing product portfolio, the fit between the product and market requirements and in the relative contribution of supporting functional processes in the innovating organization, such as the marketing and distribution functions (Cooper and Kleinschmidt 2000; Dutta et al. 1999; Storey and Easingwood 1993).

Evidence was also found that an appropriate organization structure (Burns and Stalker 2001; Cooper 1992; Tushman and O'Reilly III 1996) and the effective management of the new product or service development (NSD) process (Ahlert and Evanschitzky 2002; Jensen and Harmsen 2001) substantially affect the performance of the innovation process (Cooper and Edgett 1996; Storey and Easingwood 1993).

Due to a strong focus on issues external to the new product development process (Martin and Horne 1995) little research has been devoted to factors affecting the quality of managerial decision-making during the innovation process. However, decision-making during the NSD process is severely complicated by very high levels of uncertainty and complexity, and we therefore expect that improvements made with respect to decision-making performance during the NSD process will substantially affect the success of innovations (Cooper and Edgett 1996) and innovation process performance (Cyert and March 1992; Shapira 1997; Simon 1997). By means of their decisions, managers transform information into action (March 1991). Some recent studies already pointed at the important role organizational communication and information processes potentially play in determining service innovation success (Lievens 1996; Lievens and Moenaert 2000b; Moorman 1995). Because of this supposedly critical role of information in high-tech service innovation, the identification of information processing related antecedents of decision-making performance should receive high priority in research. The problem statement of this study will therefore be:

- *Which factors affect, through their influence on the effectiveness of organizational information processing and decision-making, the performance of the high-tech service innovation process?*

In this chapter, an information processing perspective is thus adopted with

the objective of investigating inter-firm variance in high-tech service innovation performance. Uncertainty is considered one of the major moderators of effective and rational decision-making in the extremely turbulent environment of high-tech service innovation¹ (Lievens and Moenaert 2000b). As a consequence, the extent to which the organization succeeds in reducing the uncertainty surrounding the decision-makers will contribute to their effectiveness (Galbraith 1973; Galbraith 1974). We expect that several factors play a major role in the reduction of the uncertainty surrounding key decision-makers. Relevant information must be collected and communicated to the key decision-makers, who must then process the information effectively. In order to guide the present investigation we derived the following three research questions:

- RQ 1:** *Which factors relating to the content of the information affect high-tech service innovation performance?*
- RQ 2:** *Which organizational factors, related to information processing, affect high-tech service innovation performance?*
- RQ 3:** *Which factors, relating to the processing of information by individual decision-makers, affect high-tech service innovation performance?*

The remaining part of the chapter is structured as follows. First, in the form of a literature review guided by the research questions, antecedents of effective information processing and decision-making in the innovation process are systematically identified. Propositions are formulated as to the effect of these antecedents on the probability of innovative success. Subsequently, these propositions are integrated in a theoretical model. We then present

¹See also Chapter Three

findings from a study that was designed in order to obtain empirical support for our propositions. Furthermore, an extensive discussion of the findings and managerial implications are provided. Finally, limitations of the current study and suggestions for further research are presented.

5.2 Literature Review and Development of Propositions

Uncertainty occurs in different forms and at different levels during the various stages of the innovation process. Both the nature of the uncertainty and the way decision-makers address it differ substantially for the strategic and the operational phases of the innovation process. As a result we expect the antecedents of effective innovation decision-making to differ as well. Therefore the two phases of the innovation process will be investigated separately. We start the investigation with the strategically important initial go-no-go decision phase.

5.2.1 Strategic Innovation Decision Making

Ultimately, each commercial innovation process starts with an evaluation and approval of a new product or service proposal by the firm's top-management. In most service firms the marketing or R&D department generates a stream of ideas and proposals for new services. Information pertaining to customer benefits produced by the new service, requirements in terms of company resources and details with respect to the development and commercialization processes are presented to a select group of decision-makers. These managers evaluate the proposals and make a so-called initial go-no-go decision

for each of them. Since there is inherent variance in the quality, originality and value for the company of the various proposals, the purpose of the go-no-go decision process is to select those new service projects that will significantly contribute to performance and simultaneously serve the firm's strategic objectives. When a project is considered worthy of developing and commercializing, it will often be assigned a level of priority. According to this level of priority company resources are then proportionally allocated to the development and introduction of the new service. In most cases, the project is subsequently handed over to a project team that will take responsibility from then on.

The go-ahead is thus given in a so-called go-no-go decision. Since environmental threats can be neutralized and opportunities seized by a well-chosen introduction of new products and services, the scope of this go-no-go decision is strategic (Porter 1980; Porter 1985). The decision to invest in the development of one service, and not in another, will have important consequences for the deployment of resources and development of key competencies, have an impact on the further evolution of the firm (Barney 1991; Barney 2001) and its future well-being and must thus be considered a strategic decision. We expect that an appropriately made initial go-no-go decision, i.e. the selection of those proposals that are most promising against the background of company resources and strategy, will increase the probability of success of individual projects, as well as the overall performance of the firm, as a result of a strategically better balanced product portfolio.

Three research questions have been formulated with respect to the role of information in determining the quality of innovative decision-making. We will first interpret and answer these questions with respect to the initial go-no-go decision.

5.2.1.1 Information used in Go-No-Go Decisions

An evaluation of relatively vague innovation proposals against the background of company objectives and environmental factors is very complicated, and involves, like any other strategic decision, extreme levels of uncertainty. The uncertainty can be limited by using appropriate information during the evaluation process. The extent to which various sources of information are used is by no means standardized and depends on the organizational routines that implicitly or explicitly prescribe the acquisition of information prior to strategic decisions.

Several categories of information can be considered. First, the use of financial information in the go-no-go decision process could create a more balanced perspective on the resources available and the resources needed and can therefore contribute to the quality of the decision and the allocation of the appropriate resources. Second, the use of a marketing plan, containing information pertaining to the long-term product-market strategy of the company, will contribute to a better positioning of the new service within the product portfolio and thus to the allocation of an appropriate amount of resources to the marketing effort. For similar reasons, the use of the business plan in the go-no-go decision can lead to the selection of projects that fit well with the strategic objectives of the company. This will lead to greater alignment with other products, which seems especially important when investment decisions are made with respect to very expensive projects. We expect:

Proposition 5.1 *High-tech service innovation projects performed in firms where internal information is used in the go-no-go decision process are likely to be more successful.*

The three information sources discussed so far all contain internal company data. This information does not create any insight in the existence of market opportunities. In order to enable decision-makers to judge the proposals for their commercial viability, external information is therefore also often being gathered. By means of market research, companies gather information about market opportunities and competitive threats. We expect:

Proposition 5.2 *High-tech service innovation projects selected in firms where market research is performed preceding the go-no-go decision are likely to be more successful.*

5.2.1.2 The Role of the Organization

The outcome of the assessment of new service proposals is not only dependent on which information is presented to the decision-makers, but also on the interpretation of that information in relation to the proposal by the decision team. In the above we have argued that the go-no-go decision is essentially strategic in nature. The perspective within which decision-makers consider a proposal can vary in terms of the time horizon. Operational decisions are generally taken within a relatively short-term perspective, whereas strategic decisions are taken within a long-term perspective. The perspective can also vary in terms of the risk attitude of the decision-makers. Operational decisions are taken in order to limit risk as much as possible, whereas in strategic decision-making a certain amount of risk is necessarily taken. In order to assess new service proposals as strategic options of the firm, an entrepreneurial attitude and a long-term view will contribute to the interpretation of the go-no-go decision as a strategic decision. We thus expect there to be a positive relationship between the extent to which the decision-makers take a strategic perspective while evaluating the proposal and the probability of success:

Proposition 5.3 *High-tech service innovation projects selected in organizations where a long-term perspective and an entrepreneurial attitude are adopted during the go-no-go decision process are likely to be more successful.*

5.2.1.3 Decision Maker Capabilities

Finally, the extent to which decision-makers actually select the relevant cues from the information and the resulting efficiency with which the information is used play an important role. We expect that the efficiency of information use during the go-no-go decision will depend on the decision-makers involved and, related, their ability to make highly complex strategic decisions. For an appropriate evaluation of new service proposals, insight in the strategic options of the firm seems to be a necessary condition. Since top management is most knowledgeable with respect to strategic options as they are the originator of strategy (Hambrick and Snow 1977; Harrison and Pelletier 1998), we expect:

Proposition 5.4 *High-tech service innovation projects performed in firms where top management is involved in the initial go-no-go decision are likely to be more successful.*

Although the involvement of top management in the go-no-go decision seems to be indispensable, the involvement of operationally knowledgeable managers in the go-no-go decision could help in making the allocation of resources more realistic. Managers at an operational level are supposed to have more detailed knowledge of the market requirements, organizational resources and technological possibilities. We therefore expect:

Proposition 5.5 *High-tech service innovation projects performed in firms where knowledgeable decision-makers on an operational level are involved in*

the go-no-go decision are likely to be more successful.

5.2.2 Operational Decision-Making in the NSD Process

In general, the operational phase of new service development starts when an approved project is handed over to a project team. Although, strictly speaking, most decisions relating to the development of the new service are no longer of a strategic nature, very high levels of uncertainty still occur, as a result of the speed of technological developments, rapid changes in customer requirements and all sorts of competitive developments in the marketplace. Since decisions in the operational phase of the service development must lead to concrete, precise and executable action, uncertainty needs to be reduced to a greater extent than in the strategic phase. We therefore expect effective information acquisition, diffusion and use to play an even more important role in the development stage than in the strategic phase.

5.2.2.1 The Role of Intelligence Gathering

In an environment that is subject to unpredictable and rapid change, the availability of up-to-date information to the managers involved in the innovation process will improve their decision-making effectiveness. The amount of effort a firm puts into intelligence-gathering activities is therefore expected to play an important role with respect to the performance of the innovation process (Lievens and Moenaert 2000b):

Proposition 5.6 *There will be a positive relationship between the effort a firm puts into gathering intelligence and the relative success of innovations performed in that firm.*

Organizational intelligence gathering is traditionally assumed to take place in three domains (Van den Bulte et al. 2002). First, companies generally collect competitive intelligence, i.e. information about the strategic moves of their competitors in the marketplace. Second, technological intelligence is gathered with respect to changes in the dominant technologies in the industry. Finally, companies put effort in collecting information about trends in consumption patterns and changing customer requirements. We expect:

Proposition 5.7 *There will be a positive relationship between the effort a firm puts into gathering intelligence with respect to technology (1), competitor's strategies (2) and customer requirements (3), and the relative success of innovations performed in that firm.*

5.2.2.2 The Role of Organizational Factors

The quality of internal and external communication affects information diffusion throughout the organization. We expect that communication will moderate the availability of information to the decision-makers and therefore will have a direct effect on the performance of the innovation process. However, especially in turbulent environments such as the one surrounding the high-tech service innovation process, there is often little time available for formal reporting. We therefore expect informal communication, both on an internal and on an external level, i.e. with suppliers and customers, to contribute substantially to the acquisition and diffusion of information. Especially in service innovation the product contains many intangible or experience aspects, as well as complex aspects that necessarily combine aspects from different knowledge domains, making it difficult to make every detail explicit. As a result of these circumstances we expect the exchange or transfer of tacit knowledge to play an important role in the new service develop-

ment process (Madhavan and Grover 1998). Tacit knowledge is transferred through informal contact rather than through formal communication. We expect that informal communication will thus directly influence the availability of information to the decision-maker and therefore:

Proposition 5.8 *In the case of high-tech service innovation, there will be a positive relationship between the extent to which the organization stimulates informal information exchange and the success of innovations developed in that firm.*

Another factor that will especially affect the speed and accuracy with which the externally acquired intelligence reaches the decision-maker is what we would like to call an innovative organizational climate. An innovative climate consists of an environment stimulating innovation related communication, and the sharing of information (Burns and Stalker 2001), and it therefore improves the transfer of relevant information to and from the decision-makers. We expect a direct positive effect of such an innovative climate on the innovative performance of the organization:

Proposition 5.9 *In the case of high-tech service innovation, there will be a positive relationship between the extent to which the organization maintains an innovative climate and the success of innovations developed in that firm.*

The more effort a company puts into gathering intelligence, the more important the creation and maintenance of an innovative climate will be perceived by the people active in the organization. We therefore expect an innovative climate also to mediate the effect on innovation process performance of the effort the company puts into gathering intelligence. In other words:

Proposition 5.10 *In the case of high-tech service innovation, the positive relationship between the extent to which the organization puts effort into gathering intelligence and the success of innovations developed in that firm will be mediated by the extent to which the organization maintains an innovative climate.*

5.2.2.3 Factors Relating to the Decision Maker

Once information has been acquired and diffused through the innovating organization, and communicated to the decision-maker, the manager still has to make efficient use of it. It is often argued that decision-making improves when the decision-maker has experience with the subject matter (Perkins and Rao 1990). Experience will facilitate the rapid selection of relevant cues and therefore lead to better decisions under time pressure. The level of decision-maker experience can be considered a proxy for their individual absorptive capacity (Cohen and Levinthal 1990) built up over the years, allowing the manager to recognize complex patterns in new information (Simon 1987), and thus interpret and learn from that new information. This will affect the extent to which the decision-maker can actually use the information effectively. We thus expect:

Proposition 5.11 *There will be a direct positive relationship between the amount of experience in key decision-makers involved in the new service development process and new service success.*

Experience is accumulated on the job, i.e. without any proactive involvement of the decision-makers. However, their absorptive capacity can also be increased in a proactive way, by attending seminars and courses. In an industry where rapid developments take place in all knowledge domains, active

updating seems to be extremely important. Although many companies propagate an attitude of life-long learning, the extent to which this is practiced in organizations is variable. We expect:

Proposition 5.12 *There will be a positive relationship between the extent to which the involved decision-makers update their knowledge systematically and new service success.*

Proposed relationships with respect to the strategic and the operational phases of the new service development process are summarized and visualized in a conceptual model presented in Figure 5.1. In this model, the antecedents of both sound strategic decision-making and effective operational decision-making are affecting the chances of innovation success, albeit via different paths.

5.3 Research Design

The purposes of the empirical study were to validate the conceptual model presented in Figure 5.1, and to explain a substantial part of the variance in new service performance in terms of variance in information acquisition, diffusion and use, and this at two levels of decision-making, the strategic level and the operational level. Data therefore had to be collected about a large number of high-tech service innovations, with sufficient variance in performance.

5.3.1 Sampling

An electronic questionnaire was designed and put on the Internet server of Maastricht University. Subsequently, we approached the International Asso-

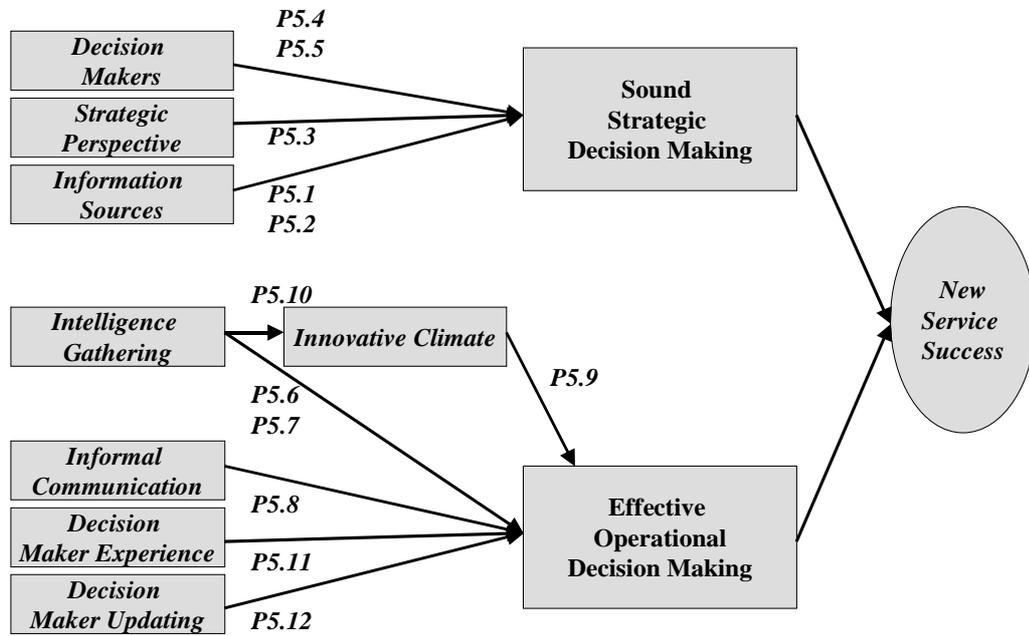


Figure 5.1: Antecedents of New Service Success

ciation For Services Management (AFSMI)², a global organization dedicated to furthering the knowledge, understanding, and career development of executives, managers, and professionals in the high-technology services and support industry. Via their electronic mailing list, an invitation to participate in the survey, with a short motivation and the endorsement from an AFSMI official (Vice President Europe, Middle East and Africa) was sent to senior executives from approximately 1500 companies active in high-tech service sectors. The e-mail clearly stated the purpose and relevance of the present study, and included a hyperlink directing the participants to the online survey. As an incentive to participate, we offered the participants to receive a summary of the results via e-mail.

5.3.2 Method

We drew up the questionnaire in the form of a range of positive statements. We asked the participants to indicate the extent to which they agreed with those statements on seven-item Likert scales. The scales were anchored on both extremes and went from ‘strongly disagree’ (1) to ‘strongly agree’ (7). The questionnaire has been pre-tested on a limited sample for intelligibility and feasibility in a printed format. The definitive electronic questionnaire contained approximately one hundred and ten undisguised statements, topically organized (Judd et al. 1991). We explicitly asked the participants to answer all questions with respect to one recent specific service innovation project.

²See www.afsmi.org

5.4 Results

5.4.1 Sample Characteristics

A total of 251 usable questionnaires were received within two weeks from the mailing of the initial invitation. According to the AFSMI official, who regularly organized web-based surveys, the response rate did not significantly deviate from the results of earlier studies. The nonresponse bias was assessed by means of an examination of differences between early and late respondents. The results were non-significant. As a consequence, nonresponse bias does not appear to play a role in the present investigation, and the homogeneity of the sample has lead us to believe in the external validity of the study (Armstrong and Overton 1977). As a result of the use of a well-designed online measurement instrument the number of missing values was extremely small.

All participants were employed in companies making use of high-tech services either as a core business or as supporting services for other core products. In Figure 5.2 the distribution of the participants over different industry sectors is made visible.

From Figure 5.2 it becomes clear that high-tech services already play a role in many major areas of the global economy. In Figure 5.3, an overview of the functions of participants in the survey is presented.

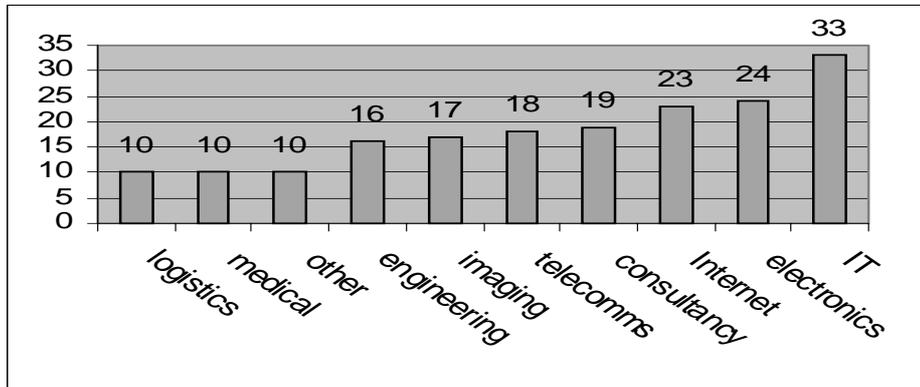


Figure 5.2: Industry Origin of Survey Participants

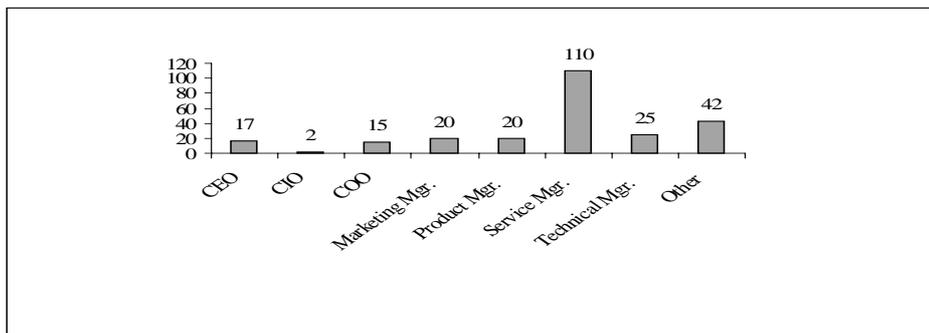


Figure 5.3: Function of the Respondents

5.4.2 Measures

Existing scales were unavailable to assess most of the constructs of our study. Based on a review of the innovation success literature we therefore developed several new measures. First, the perceived performance of the new service development process had to be assessed. In different studies different conceptualizations of new service success or performance have been proposed and used. It can be argued that the conceptualization and measurement of service performance will depend on the service category under scrutiny. Different performance criteria will exist, for example, with respect to core services and customer services. In the case of a core service, its financial performance will be an important criterion, whereas in the case of a supporting service customer satisfaction may be the most important performance measure. However, we argue that the fundamental purpose of all services is to contribute, albeit via different routes, to the overall performance of the company, from both a short-term perspective *and* a long-term perspective. We therefore conceptualized new service success as a multidimensional latent construct and decided to measure it via a large number of indicators, taken from various studies. We designed a preliminary questionnaire and included fifteen items in the survey, pertaining to the perceived success of the service and its performance in various dimensions. Based upon the results of the pretest, arrived at by means of an iterative factor analysis, we finally selected twelve items to be included in the definitive questionnaire. First, an exploratory principal component factor analysis was performed on the twelve variables in the definitive questionnaire, which resulted in a three-factor solution (using '1' as the cut-off value for the Eigenvalues), explaining 69 % of the total variance. For an overview of the composition of the factors we refer to Table 5.1. Based upon the outcome of the factor analysis we constructed

three new variables, S1, S2 and S3. The interpretation of the obtained factors remains a subjective matter (Hair et al. 1998), and must be based upon the components represented in the factor. Our interpretation of these factors is that the meaning of S1 lies very close to what we view as the most salient aspects of success. If the service was successful in terms of S1, we interpreted this as meaning that the decision to invest in the innovation was essentially right. Services successful in this sense were obvious successes, but within a short-term horizon. The meaning of S2 has a deeper, more technical meaning, in the sense that the new service is a genuine *business* success; the new service creates competitive advantage on a long-term basis. The third success factor seems to point at indirect positive results, and takes other than financial stakeholders into account. When a new service is considered successful in the sense of S3, it means that the service creates conditions for improved company performance in the future. Obviously, all three forms of success are ultimately important for firm survival, and intentions to stress one aspect more than another will probably depend on the time horizon that decision-makers have in mind. A second order confirmatory factor analysis was conducted in Lisrel (Jöreskog and Sörbom 1989). The second order factor resulting from this analysis was then used as the dependent variable 'Success' in the study. The fit values for the second order analysis were quite good. From these results we can conclude that the three identified factors indeed converge in a higher order factor 'New Service Success'. We measured a GFI of 0.96, AGFI 0.94, NFI 0.96, with χ^2 of 61.62 (Df. =47), P=0.12 and RMSEA of 0.031. Standardized factor loadings and reliability coefficients are reported in Table 5.1.

In order to be able to find support for the propositions regarding the strategic decision process we included items in the questionnaire inquiring

Item: The New Service...	S1	S2	S3	Success
	$\alpha=.87$	$\alpha=.84$	$\alpha=.75$	$\alpha=.91$
Is an Overall Success	.69	–	–	
Success Exceeds Expectations	.73	–	–	
Adds Substantial Value to other Products and Services	.89	–	–	} .81
Was a good Idea to Invest in	.75	–	–	
Contributed to Financial Performance	.82	–	–	
Contributed to Commercial Performance (Market Share)	–	.78	–	
Improved our Competitive Position	–	.82	–	} .93
Improved Brand Equity & Reputation	–	.68	–	
Enabled Expansion into New Markets	–	.75	–	
Increased In-house Technological Knowledge	–	–	.69	
Increased Employee Satisfaction	–	–	.74	} .79
Created Innovation Opportunities	–	–	.63	

Table 5.1: Composition of the Dependent Variables

into the use of a specific information source, the involvement of a type of decision-maker and the adoption of a strategic stance. These questions could be answered with a simple yes or no, and were transformed into dummy variables. For an overview of the items included in the questionnaire we refer to Tables 5.5, 5.6 and 5.7, where the findings are reported.

Subsequently, a measurement instrument for intelligence activities of the organization (INTELL) was constructed, based on measures developed by Van den Bulte et al. (2002). Nine items were included in the questionnaire, three to measure intelligence activities with respect to developments in the field of technology (TECH), three to measure information gathering with respect to competitive strategies (COMP) and three to measure intelligence activities with respect to customer requirements (CUST). We performed a principal component factor analysis in order to validate the constructs. As expected, three factors were found, using the common cut-off value of '1' for the Eigenvalues, explaining 79 % of the total variance. Subsequently we performed a second order confirmatory factor analysis in Lisrel. The factor loadings, first and second order, of this second order analysis are reported in Table 5.2. Reliability of the multi-item scales is also reported in this table. Again we measured very good fit statistics. GFI of 0.96, AGFI 0.93, NFI 0.97, with a χ^2 of 44.36 (Df. =24), P 0.01 and RMSEA of 0.058. From these results we can conclude that the three identified factors indeed converge in a higher order factor 'intelligence gathering'.

The composition, standardized factor loadings and reliability values of the other independent factors are reported in Table 5.3. In a confirmatory factor analysis performed in Lisrel we obtained the following excellent fit measures: χ^2 64.78 (Df=38), P= 0.0047 GFI = 0.96; AGFI = 0.92; CFI = 0.97; RFI = 0.89; RMSEA = 0.053.

Item	TECH	COMP	CUS	INTELL
Information was gathered about:	$\alpha=.83$	$\alpha=.90$	$\alpha=.85$	$\alpha=.87$
User friendliness of Technologies	.75	–	–	
Cost-efficiency of Technologies	.83	–	–	} .60
Performance of Technologies	.78	–	–	
Marketing Strategy of Competitors	–	.85	–	
Technological Strategy of Competitors	–	.86	–	} .72
Innovation Strategy of Competitors	–	.88	–	
Changes in Customer Needs	–	–	.79	
Changes in the Market	–	–	.82	} .83
Change in User Requirements	–	–	.83	

Table 5.2: Organizational Intelligence Activities

5.4.3 Data Analysis

The data set was analyzed using various statistical methods. First the data were subjected to univariate analyses of variance, in order to determine the differences in the means of the success factor, for samples that were split according to the variables relating to the go-no-go decision. In order to obtain insight in the structure of the data we conducted a correlation analysis between all major constructs. In Table 5.4 the correlations between main constructs are reported.

Furthermore, with respect to the operational part of the model, the data were submitted to a range of regression analyses, in order to determine the total amount of variance that was explained by the data. Finally we estimated the fit of the data to the conceptual model presented in Figure 5.1 in Lisrel, making use of the total aggregation method suggested by Bagozzi and Heatherton (1994).

Item:	Informal	Experience	Updating	Climate
Reliability:	$\alpha=.62$	$\alpha=.71$	$\alpha=.80$	$\alpha=.72$
Much informal Communication between Departments	.71	–	–	–
Much informal Communication with Suppliers/Partners	.67	–	–	–
Decision-Makers were Experienced	–	.63	–	–
Decision-Makers were Experts	–	.63	–	–
Decision-Makers were Multidisciplinary. Experts	–	.75	–	–
Updated Regularly in Internal Seminars	–	–	.51	–
Updated Regularly in External Seminars	–	–	.89	–
Updated in Specialist Seminars/Training etc.	–	–	.91	–
Fosters Unconventional and Creative Decision-making	–	–	–	.60
Stimulates Internal Information Exchange	–	–	–	.81
Stimulates External Information Exchange	–	–	–	.64

Table 5.3: Confirmatory Factor Analysis Independent Factors

	S1	S2	S3	S	Tech	Com	Cust	Inf	Clim	Exp
S1	1									
S2	.673**	1								
S3	.553**	.575**	1							
S	.904**	.872**	.784**	1						
Tech	.261**	.288**	.270**	.315**	1					
Com	.050	.147*	.056	.095	.376**	1				
Cust	.306**	.360**	.247**	.357**	.425**	.520**	1			
Inf	.301**	.228**	.148*	.276**	.262**	.171**	.284**	1		
Clim	.343**	.359**	.325**	.398**	.447**	.246**	.484**	.211**	1	
Exp	.200**	.167**	.085	.185**	.207**	.034	.164**	.113	.109	1
Upd	.312**	.264**	.284**	.336**	.178**	.099	.338**	.198**	.342**	.149*

** . Correlation is significant at the 0.01 level (2-tailed)

* . Correlation is significant at the 0.05 level (2-tailed)

Table 5.4: Pearson Correlation between Main Constructs

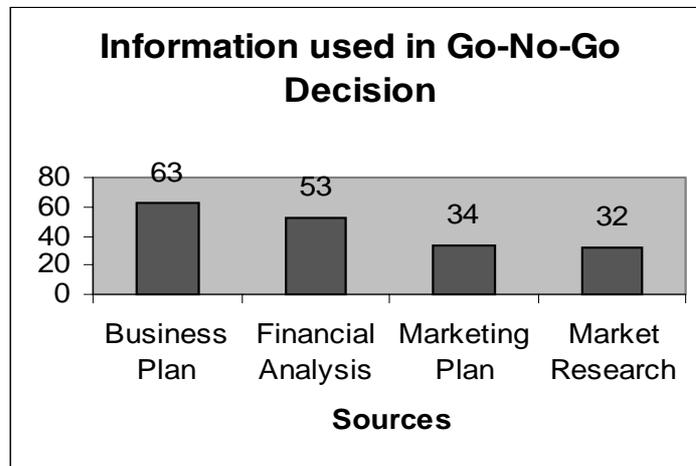


Figure 5.4: Types of Information Used in Go-No-Go Decisions In Items of Percentage

5.4.4 Propositions Regarding the Strategic Phase

We tested the propositions regarding the strategic go-no-go decision by comparing the means of the three success variables, obtained via the above reported factor analysis, as well as the overall success variable in an ANOVA, using the dummy variables for information sources, function of the decision-maker and strategic perspective obtained via our questionnaire as factors. We only included one variable at a time, in order to obtain main effects. In Figure 5.4 we present an overview of the distribution of information source usage during the go-no-go decision over all innovation projects. A business plan was e.g. used during the decision in 63 percent of all innovation projects.

From Figure 5.4 it becomes clear that most companies use reports containing information with respect to the company itself and the strategy. However, only in case of one third of the innovations the decision-makers have used information obtained through market research. In Table 5.5 we present the

results with respect to the ANOVA of the information sources and the four success variables. This table shows that each of the sources of internal information contributes to the success of the innovation in various dimensions. It also shows that the use of information from market research contributes substantially to the probability of success in nearly all dimensions.

In Table 5.6 we present the results from an ANOVA performed on the two dimensions of the attitude towards the initial go-no-go decision on the various success measures. From this table it can be seen that the adoption of both a long-term vision and an entrepreneurial stance affect the probability of success in nearly all dimensions.

In Figure 5.5 we present an overview of the relative involvement of various managers in the initial go-no-go decision. From this figure it appears that the go-no-go decision is mainly the territory of decision-makers on an operational level, while the CEO or other top managers are involved in slightly more than half the decisions. In Table 5.7 the results are presented from the ANOVA that was conducted from the dummy variables associated with the participation of a member of the managerial staff in the initial go-no-go decision on the various success factors. The table shows that no differences in the means of the success measures were observed between innovations where operational managers were involved or not. The participation of top managers appears to make a difference. Participation of the CEO is positively related to what we have interpreted as 'genuine business success' (S2). Participation of the CIO is significantly related to the third dimension of success and almost significantly to overall success, and the participation of the COO is positively related to nearly all dimensions.

Information		Between Groups		Within Groups		F	Sig.
		Mean Square	Df	Mean Square	Df		
Business Plan	S1	11.590	1	1.480	249	7.831	.006
	S2	1.295	1	1.368	249	.947	.331
	S3	2.682	1	1.599	249	1.677	.196
	S	4.872	1	1.092	249	4.461	.036
Marketing Plan	S1	2.276	1	1.517	249	1.500	.222
	S2	9.818	1	1.334	249	7.362	.007
	S3	.185	1	1.609	249	.115	.735
	S	2.451	1	1.102	249	2.225	.137
Financial Analysis	S1	7.230	1	1.497	249	4.828	.029
	S2	1.803	1	1.366	249	1.320	.252
	S3	1.210	1	1.605	249	.754	.386
	S	3.396	1	1.098	249	3.093	.080
Market Re-search	S1	9.218	1	1.489	249	6.189	.014
	S2	13.453	1	1.319	249	10.199	.002
	S3	3.326	1	1.596	249	2.083	.150
	S	8.665	1	1.077	249	8.046	.005

Table 5.5: Testing of Propositions I

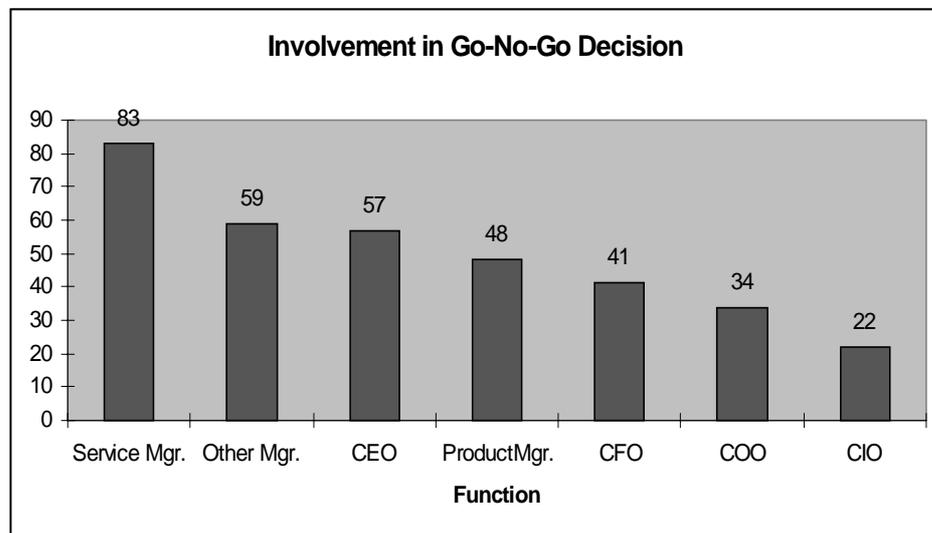


Figure 5.5: Involvement in the Go-No-Go Decision in Items of Percentage

		Between Groups		Within Groups		F	Sig.
		Mean Square	Df	Mean Square	Df		
Long Term Vision	S1	18.674	1	1.451	249	12.865	.000
	S2	21.556	1	1.286	249	16.757	.000
	S3	18.536	1	1.535	249	12.073	.001
	S	19.576	1	1.033	249	18.950	.000
Entrepreneurship	S1	19.213	1	1.449	249	13.257	.000
	S2	20.062	1	1.292	249	15.523	.000
	S3	5.355	1	1.588	249	3.372	.068
	S	15.194	1	1.051	249	14.461	.000

Table 5.6: Testing of Propositions II

Table 5.7: Testing of Propositions III (ANOVA)

Function		Between Groups		Within Groups		F	Sig.
		Mean Square	Df	Mean Square	Df		
CEO	S1	.123	1	1.526	249	.081	.777
	S2	10.263	1	1.332	249	7.707	.006
	S3	4.467	1	1.592	249	2.806	.095
	S	3.036	1	1.099	249	2.761	.098
CIO	S1	2.941	1	1.515	249	1.942	.165
	S2	1.239	1	1.368	249	.906	.342
	S3	12.110	1	1.561	249	7.757	.006

Table 5.7: *continued*

		Between Groups		Within Groups			
Function		Mean Square	Df	Mean Square	Df	F	Sig.
	S	3.824	1	1.096	249	3.488	.063
CFO	S1	.237	1	1.526	249	.156	.694
	S2	1.508	1	1.367	249	1.103	.259
	S3	.802	1	1.606	249	.499	.480
	S	.699	1	1.109	249	.631	.428
COO	S1	8.453	1	1.493	249	5.664	.018
	S2	8.535	1	1.339	249	6.376	.012
	S3	5.953	1	1.586	249	3.754	.054
	S	7.813	1	1.080	249	7.233	.008
Prod. Mgr.	S1	.382	1	1.525	249	.250	.617
	S2	.929	1	1.369	249	.678	.411
	S3	.213	1	1.609	249	.132	.717
	S	.215	1	1.111	249	.193	.661
Service Mgr.	S1	.247	1	1.525	249	.162	.688
	S2	.299	1	1.372	249	.167	.683
	S3	.619	1	1.607	249	.385	.536
	S	.317	1	1.100	249	.286	.593
Other Mgrs	S1	.212	1	1.526	249	.139	.710
	S2	.215	1	1.372	249	.157	.692
	S3	.007	1	1.610	249	.004	.947

Table 5.7: *continued*

		Between Groups		Within Groups			
Function		Mean Square	Df	Mean Square	Df	F	Sig.
	S	.003	1	1.112	249	.003	.956

In our view, there is no doubt about the existence of multiple interaction effects. For lack of existing theory we did not develop propositions with respect to these interaction terms. Furthermore, the variables do not explain unique variance. Clearly, some overlap exists between the contributions of different information sources, and between the strategic capabilities of different managers. We provide an overview of the propositions and their status in Table 5.8.

Table 5.8: Overview of the Propositions Part 1

Nr.	Description	Status			
		S1	S2	S3	S
P 5.1	High-tech service innovation projects performed in firms where internal information is used in the go-no-go decision process are likely to be more successful:				
	Business Plan	√	–	–	√
	Marketing Plan	–	√	–	–
	Financial Information	√	–	–	–

Table 5.8: *continued*

Nr.	Description	Status			
		S1	S2	S3	S
P 5.2	High-tech service innovation projects selected in firms where market research is performed preceding the go-no-go decision are likely to be more successful.	✓	✓	–	✓
P 5.3	High-tech service innovation projects selected in organizations where a long-term perspective and an entrepreneurial attitude are adopted during the go-no-go decision process are likely to be more successful.	✓	✓	✓	✓
P 5.4	High-tech service innovation projects performed in firms where top management is involved in the initial go-no-go decision are likely to be more successful.				
	CEO	–	✓	–	–
	CIO	–	–	✓	–
	CFO	–	–	–	–
	COO	✓	✓	✓	✓

Table 5.8: *continued*

Nr.	Description	Status			
		S1	S2	S3	S
P 5.5	High-tech service innovation projects performed in firms where decision-makers on an operational level are involved in the go-no-go decision are likely to be more successful.	–	–	–	–

5.4.5 Propositions Regarding the Operational Phase

First, we regressed the three obtained success factors, as well as the second order overall success factor in a multivariate regression on all postulated independent variables. The results of these regressions are presented in Table 5.9.

From Table 5.9 it becomes clear that positive significant effects are found for two of the intelligence factors (Tech and Cust) with respect to most of the success factors, as well as negative significant effects for competitive intelligence gathering (Comp) with respect to S1 and overall success. This implies that our propositions $\mathbf{P}_{5.6}$ and $\mathbf{P}_{5.7}$ are supported by the data for technical and customer intelligence, but rejected for competitive intelligence, as we found the opposite effect there. A positive significant effect was demonstrated between informal communication and two of the success factors, S1 and overall success, implying partial support for $\mathbf{P}_{5.8}$.

Table 5.9: Regression of Success Factors (Operational Stage)

Dependent	S1				S2				S3				S			
	B	Beta	t	Sig	B	Beta	t	Sig	B	Beta	t	Sig	B	Beta	t	Sig
Independent	F=11.020 Sig.=. 000 R ² = . 241				F=9.270 Sig.=. 000 R ² = . 211				F=7.024 Sig.= .000 R ² = . 168				F=13.009 Sig.=.000 R ² = .273			
Constant	1.545		3.096	.000	1.697		3.517	.000	2.384		4.445	.000	1.806		4.331	.000
Technology		.083	1.225	.222		.092	1.324	.187		.161	2.265	.024		.123	1.850	.065
Competitor		-.149	-2.211	.028		-.061	-.883	.378		-.116	-1.639	.103		-.130	-1.971	.050
Customer		.146	1.912	.057		.195	2.507	.013		.089	1.119	.264		.170	2.281	.023
Informal		.186	3.124	.002		.094	1.547	.123		.030	.486	.627		.135	2.312	.022
Climate		.169	2.450	.015		.177	2.521	.012		.173	2.405	.017		.200	2.968	.003
Experience		.101	1.752	.081		.074	1.250	.212		-.007	-.123	.902		.075	1.317	.189
Updating		.154	2.492	.013		.098	1.563	.119		.173	2.678	.008		.163	2.707	.007

We found positive significant effects for the innovative climate with respect to all success factors, implying that our data fully support $\mathbf{P}_{5.9}$.

With respect to the factors relating to the decision-maker, Table 5.9 demonstrates that there is no significant relationship between the decision-maker's experience and innovative success, which indicates that there is no support in the data for $\mathbf{P}_{5.11}$. We did find support, however, for our proposition $\mathbf{P}_{5.12}$, stating that there would be a positive relationship between the extent to which decision-makers would update their knowledge on a regular basis on the one hand, and innovative success on the other. Positive and significant relationships were demonstrated with respect to all success factors, with the exception of S2.

5.4.5.1 Mediation Test

In proposition $\mathbf{P}_{5.10}$ it was posited that the influence of the amount of effort a company puts into gathering intelligence (Independent Variable) on the extent to which the resulting innovation would be considered a success (Dependent Variable) would be mediated by the extent to which the organization maintains an innovative climate (Mediator). In order to test for mediation (Baron and Kenny 1986), we applied the Sobel test (MacKinnon and Dwyer 1993; MacKinnon et al. 1995; Sobel 1982) to the factors obtained in the second order analyses for the IV and the DV and the first order factor for the Mediator.

The test statistic was calculated according to the following formula:

$$\mathbf{z\text{-value}} = \mathbf{a*b/SQRT(b^2*s_a^2 + a^2*s_b^2 + s_a^2*s_b^2)}$$

Where \mathbf{a} is the unstandardized path coefficient of a regression of the IV (Intelligence) on the Mediator (Climate), \mathbf{b} and \mathbf{c} the unstandardized path coefficients of a regression of the mediator and the IV on the DV (Innovation

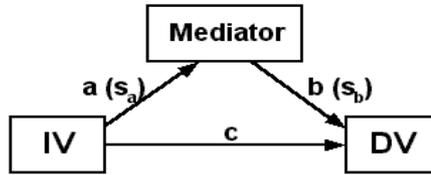


Figure 5.6: Mediation. Source Preacher and Leonardelli (2001)

Success). S_a and s_b are the standard errors of a and b respectively.

In a two-tailed Z-test of the hypothesis that the mediated effect equals zero in the population, we obtained a P-value of ≤ 0.0001 , and a Z-value of 4.2124. Since 1.96 is the critical value of the test ratio, containing the central 95% of the unit normal distribution, we conclude that there is indeed a mediation effect. The data therefore support our proposition $P_{5.10}$.

Based upon the findings from the regression analyses and the result from the mediation test it was concluded that the structure of our conceptual model of the operational phase of the new service development process adequately represents reality.

5.4.5.2 Estimation of the Model

In order to estimate the relationships in the conceptual model, a regression analysis was performed in LISREL. With the objective of constructing proxies for the constructs in the model, the total aggregation method (Bagozzi and Heatherton 1994) was used. With respect to the dependent variable, all twelve indicators were taken together. Inspection of the incremental goodness-of-fit criteria made clear that the estimated model has a decent fit (cf. Hu and Bentler 1999) to the data: GFI = 0.98; AGFI = 0.90; CFI =

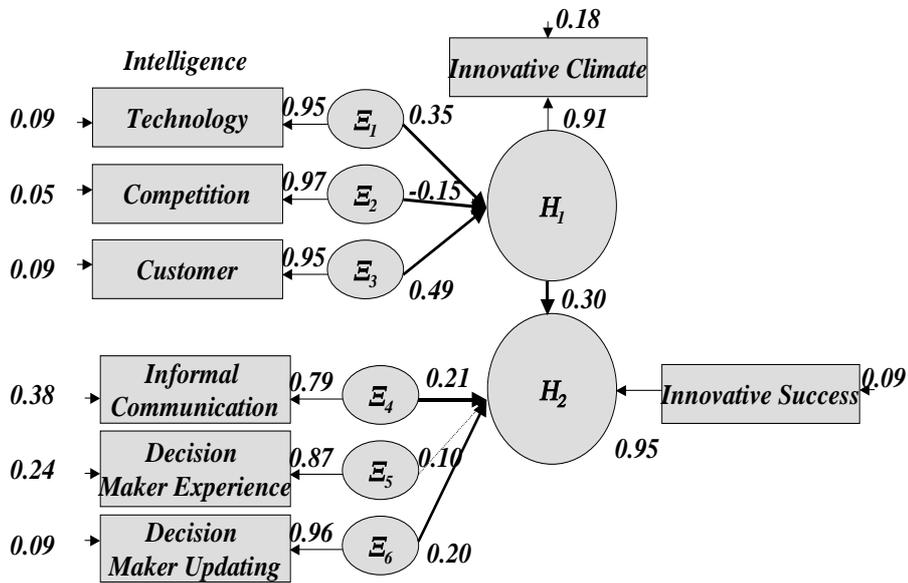


Figure 5.7: Structural Equations Model

0.97; RFI = 0.83; RMSEA = 0.086. Results are presented in Figure 5.7.

In Table 5.10, an overview is presented of the propositions that were developed with respect to the operational stage of the high-tech service innovation process and their status.

Table 5.10: Overview of the Propositions Part II

Nr.	Description	Domain	Status			
			S1	S2	S3	S
P 5.6 P 5.7	There will be a positive relationship between the effort a firm puts into gathering information and the relative success of innovations performed in that firm.	Technical	–	–	✓	✓
		Competitive	–	–	–	–
		Customer	(✓)	✓	–	✓
P 5.8	In the case of high-tech service innovation, there will be a positive relationship between the extent to which the organization stimulates informal information exchange and the success of innovations developed in that firm.		✓	–	–	✓
P 5.9	In the case of high-tech service innovation, there will be a positive relationship between the extent to which the organization maintains an innovative climate and the success of innovations developed in that firm.		✓	✓	✓	✓

Table 5.10: *continued*

Nr.	Description	Status			
		S1	S2	S3	S
P 5.10	In the case of high-tech service innovation, the positive relationship between the extent to which the organization puts effort into gathering intelligence and the success of innovations developed in that firm will be mediated by the extent to which the organization maintains an innovative climate.	N.A.	N.A.	N.A.	√
P 5.11	There will be a direct positive relationship between the amount of experience in key decision-makers involved in the new service development process and new service success.	–	–	–	–
P 5.12	There will be a positive relationship between the extent to which the involved decision-makers update their knowledge systematically and new service success	√	–	√	√

5.5 Discussion and Conclusion

We conducted the present study with the purpose of investigating the role of information and information processing activities in determining the probability of high-tech service innovation success. Effects were studied in the

strategic and operational phases. For each stage we identified a range of information processing factors and formulated propositions with respect to their expected effects on innovation success. The propositions were summarized in a theoretical model, which was tested by means of an empirical study. An overview of the results of the first part of the study was presented in Table 5.8, an overview of the results of the second part in Table 5.10. From these overviews it becomes clear that the information processing perspective on the organization is an appropriate and productive theoretical framework for the study of high-tech service innovation. It has provided valuable answers to the three research questions that were formulated at the beginning of the chapter, and helped us substantially in answering the problem statement. When we consider the reported values with respect to the extent to which our model explained the total variance in innovation success, we must be quite satisfied. With respect to the first sub question it has become clear that selection and acquisition of information, potentially playing a major role in the reduction of the uncertainty surrounding the decision-makers, contribute to the probability of success of the new service. This observation applies for both levels of analysis we studied, i.e. the strategic and the operational level. It has also become clear, that not all information is equally relevant. Whereas the business plan, the marketing plan and financial information all play a role with respect to different forms of success, the effect of the use of market research in the go-no-go decision must also be considered an important source of information. In the second phase of the process we again obtained different effects with respect to different types of information. Strikingly, the gathering of competitive information has a significant negative effect on innovation success. It could be that companies gathering competitive information are too much focused on competitive

action and therefore perform less in the innovation process. This has potential consequences for the allocation of company resources to intelligence gathering in different domains. Our most remarkable finding is that marketing intelligence in the form of market research contributes considerably to the probability of success on both levels. The importance of the use of customer information seems to contradict the conceptualization of the high-tech service industry as an entirely technology-driven industry. Technology and the acquisition of technological information may certainly be important factors in the development of new services, but based upon our findings we must conclude that the customer plays an even more important role when it comes to the introduction of *successful* new services.

With respect to the second research question, inquiring into the contribution of organizational factors to the diffusion and use of information, based upon the results that have been obtained in this study it can be concluded that the organizational routines that determine the way in which the go-no-go decisions are made, and the use of information play an important role. With respect to the operational part of the innovation process, the data confirmed that the free flow of information is facilitated by the factors that were identified, i.e. the stimulation of informal communication, as well as an open culture.

With respect to the third research question, it can be concluded that factors relating to the individual decision-makers involved in the decisions also play a role on both levels. It is clear from our results that a strategic perspective is important during the go-no-go decision, as well as the participation of strategically competent managers in the decision process. Contrary to our expectations, we did not find any support for our proposition that experience of the decision-makers plays a role in innovation success. This

could be explained by the tremendous turbulence in the macro environment of the organization. Acquired experience and knowledge lose their validity very rapidly and may therefore not contribute to better decision-making. On the other hand the data convincingly supported the proposition that regular updating of the decision-makers leads to considerably better results in innovation success.

Concluding, the present study has contributed to a number of different strands of research. First, a significant contribution was made to the high-tech service innovation literature. A number of antecedents of high-tech service innovation success have been identified in factors affecting the reduction of uncertainty. Second, a substantive contribution was made to literature relating to market-orientation or more specifically, customer orientation, since the findings prove a significant effect of marketing related functions, i.e. the collection and use of marketing information, on the probability of high-tech service success. It was also demonstrated, that the information processing perspective can be considered very promising on both a strategic level, as well as on a tactical level. A substantial part of the variance in success can actually be explained from the variance in factors affecting the efficiency of information acquisition, diffusion and processing. The research demonstrates clearly that it matters which information is used during the go-no-go decision and that it matters who is involved in the decision.

5.5.1 Managerial Implications

Based upon the reported findings a number of recommendations can be made to high-tech service firms. First, the results with respect to the strategic phase lead to the general recommendation that the initial go-no-go decision for each new service must indeed be dealt with as a decision with strate-

gic consequences. Second, we recommend that companies use both types of information, internal company documents and reports as well as externally gathered market related information, in the go-no-go decision. Considering the current state of affairs, it has become clear that only few companies use both sources. Certainly with respect to the use of market research information during initial go-no-go decisions, currently used by little more than 10 percent of the firms in our sample, we expect that much can be gained. Furthermore, we recommend that the decision team take a long-term perspective, and an entrepreneurial attitude towards the go-no-go decision. Since we found significant differences in new service success between companies that had the CEO, CIO and COO participate in the go-no-go decision and those who did not, while this is currently the case in a relatively small percentage of high-tech service firms, it seems certainly worth considering involving especially those top managers in the strategic decisions at the outset of the new service development process. In a negative sense, we must conclude that involving the CFO or the managers at an operational level in the go-no-go decision, which is currently the case in many companies, does not appear to lead to the selection of more successful projects. Although we did not measure the effect of top-management involvement in initial go-no-go decisions on overall long-term performance of the firm, we would certainly expect there to be such an effect as a result of a more strategically coherent product portfolio.

The investigation with respect to the operational phase leads us to the conclusion that firms can substantially improve the chances of innovation success by installing an appropriate information infrastructure, because information plays such an important role. An efficient real-time information platform, providing key decision-makers with selective up-to-date and rele-

vant information about developments in customer requirements and technology, could be an important success factor. More specifically we can make the following recommendations. First, it has become clear that the structured acquisition of information with respect to developments in technology and customer requirements can make a substantial difference in the success of innovations. This implies that firms should invest in structured intelligence activities in these two dimensions. Intelligence activities should focus on the identification of trends in consumer needs, and e.g. patterns of satisfaction/dissatisfaction with existing services, both provided by the firm as well as by its competitors. Feedback from e-service quality monitoring could be used as an input for new service development, both on a strategic as well as on an operational level. The structural gathering of technological intelligence will also contribute to the effectiveness of operational decision-making: probably to both the speed and the quality of the new service development process. In our sample, the acquisition of information relating to competitors' strategic moves does not make a positive contribution. On the contrary, a significant negative effect was found for the relationship between competitive intelligence and new service success. It seems therefore recommended to use competitive information exclusively at a strategic level. Second, an open, informal culture that is favorable to innovation clearly and significantly affects the chances of success. It can therefore be recommended to create the conditions that facilitate the informal exchange of information between colleagues from different departments and teams, but also between innovation managers and customers and suppliers. Third, and finally, we recommend that companies stimulate and facilitate the regular updating of their innovation related staff, by means of organizing internal seminars for knowledge exchange as well as offering them the opportunity to attend external seminars.

5.5.2 Limitations and Suggestions for Further Research

As with every study, a number of limitations are necessarily associated with this chapter. The role of information with respect to new service success was expected to be more important at the operational level, than at the level of the go-no-go decision. Still we feel that the go-no-go decision should be studied in much more detail, since the factors we identified explain a relatively unsubstantial part of the variance in innovation success, whereas we expected factors affecting the quality of the go-no-go decision to contribute substantially. This may imply that either the soundness of the go-no-go decision does not have a substantial impact on the success of innovations in the short run, or that important factors are still missing.

Perceived innovation success of the new service was used as a proxy for both the soundness of the strategic decision process, and the effectiveness of operational decision-making. The go-no-go decision could be studied independently of the actual success of the innovation, allowing the identification of other factors playing a role in the process, which are now possibly difficult to determine. However, in order to develop a more detailed model of the go-no-go decision we suggest that case studies³ be conducted, in order to determine the intricacies of the relationships between different factors.

The uncertainty decision-makers must address in the go-no-go decision is also distinct in nature from the more practical uncertainty occurring in the operational phases. In the operational phase uncertainty must be reduced, because it would otherwise block the process. However, during the go-no-go decision a higher level of residual uncertainty is acceptable, and much of the uncertainty seems actually to be reduced precisely by making the decision. There are also more creative aspects to strategic decision-making,

³Such as the study we reported in Chapter 3.

not based on external information, but rather on information that is internal to the decision-makers (Kahneman and Tversky 1982). We do not clearly understand the way uncertainty is reduced by making the decision rather than by collecting and processing information. More conceptual research seems to be needed here in the first place.

The purpose of the present research was essentially exploratory. A number of factors have been identified that play a role in creating an organizational atmosphere that is favorable to innovation, to the diffusion of information and knowledge throughout the firm, but we must acknowledge that this area as such is substantially under researched. We expect there to be various dynamic reciprocal and probably self-enforcing effects between collection, diffusion and use of information. Research is needed to study these factors in more detail.

We also recommend that reliable and more precise measurement instruments be developed for constructs reflecting organizational information flow characteristics. With respect to the information flow and the identification of factors impeding or facilitating the flow of marketing and technological intelligence through the organization, network analysis could prove to be an appropriate methodology.

Chapter 6

Discussion and Conclusion

The final chapter of the dissertation consists of an overview of the research, a summary of the results, managerial implications and suggestions for future research.

6.1 Introduction

The overall aim of this study was to investigate the unique task conditions and information requirements of the decision-makers in the high-tech service innovation process on the one hand, and to find antecedents and moderators of effective decision-making on the other. The underlying aim of the study was to provide service providers and decision-makers with a number of tools to improve decision-making effectiveness under the unique circumstances they encounter, and thus enable them to increase the performance of the innovation processes. In the present investigation a range of different perspectives and methodologies have been employed. The results of the study have enriched existing literature in a number of ways. In this chapter the results of preceding chapters are summarized and integrated. The chapter is organized as follows. In Section 6.2 the findings from the different studies are summarized, integrated and discussed. In Section 6.3 the theoretical and managerial implications of the study are discussed. In Section 6.4 the study is concluded, limitations are discussed and suggestions for further research presented.

6.2 Summary of the Findings

In this section the results from the preceding chapters are recapitulated. In Chapter One the problem statement that would guide us through the different parts of the study was presented and motivations for the study were provided. In Chapter Two behavioral literature concerning decision-making under uncertainty and the use of managerial intuition was reviewed and the relationship between task conditions and both the effectiveness in reducing uncertainty, and the validity of various decision styles were explored. Most

important result of this conceptual study was the identification of two fundamentally different semi-rational decision-making styles, which had not been explicitly distinguished in the literature. Consequently the cognitive continuum was extended and transformed into a cognitive style matrix. Furthermore, we made a critical attempt to structurally investigate the *scope* of the decision-making styles: Factors moderating the validity of decision-making styles under the turbulent conditions presented by the high-tech service innovation process have been identified. Subsequently, by means of an in-depth case study, the task conditions of the decision-makers in high-tech service innovation were explored in Chapter Three, and a model was constructed regarding antecedents and moderators of effective decision-making. The antecedents of effective decision-making were conceptualized in this study as the factors counteracting the task-related factors that were perceived to impede effective decision-making. In Chapter Four we developed a theoretical understanding of the effects of information on the strength of commitment managers develop to their decisions, when they are made under severe uncertainty. Finally, in Chapter Five, we applied an information processing perspective to the new service development process on an organizational level of analysis. Effects on innovation success were identified in a number of factors related to information processing in the organization.

6.3 Contributions

In this section theoretical and practical contributions of the study will be discussed.

6.3.1 Theoretical Contributions

The present research makes a number of contributions to the literature. In providing an integrated conceptual model of antecedents and moderators of decision-making style effectiveness, integrating theories from cognitive psychology and management decision-making literature, we have connected two important lines of thought and opened the way for a further development of a very promising area of research. Studies in the field of cognitive psychology have provided detailed insight in the ways the human brain processes information, while management decision-making literature has been especially interested in the relative effectiveness of decision-making styles under very challenging circumstances. The connection of the two areas leads to deeper insight in the range of antecedents of effective decision-making in the unique context of decision-making under substantial uncertainty, complexity and dynamics.

Furthermore, case methodology has been used for the study of individual decision-making under great uncertainty. It was demonstrated that this methodology can be very productive in an area that has so far mainly been studied in experiments, which are lacking the richness in behavioral detail provided by the case study methodology. The study of human decision processes in a real world environment will finally do justice to the unique way the human brain copes with extremely complex situations and turbulence, and will also provide much more realistic insight into the bounds of human rationality, and the factors that may play a role in alleviating these bounds under such circumstances.

In order to study decision-making in minute detail, experiments can be very useful, provided that their results are interpreted carefully. A major conceptual contribution to behavioral theories of decision-making was the

insight that managerial decision-making can productively be conceptualized as an information processing activity leading to both a choice and a degree of commitment to that choice. In order to fully capture decision-making effectiveness, we need to consider both decision-making results, since both results have equally important consequences for the extent to which managers *control* the performance of processes.

Finally, we have demonstrated the usefulness and productivity of applying an information processing view on the organization for the study of success factors in high-tech service innovation.

6.3.2 Managerial Implications

Practical implications of the results of the four studies are manifold. First, recommendations can be made to the individual decision-makers active in the new service development process, either on a strategic level, or on an operational level. With respect to the cognitive style we must conclude that most likely flexibility, adaptivity and a deliberate combination of experiential and rational cognition will produce the most effective decision-making style, as long as the decision-maker remains aware of the factors limiting the scope of both styles and the dangers lurking in the turbulence of the environment and the risks of information overload. In order to validate private experience accumulated and accessed through experiential cognition, we recommend decision-makers to share their thoughts with peer experts and to consider group decision-making, especially under conditions of great uncertainty. The importance of a continuous updating of the individual knowledge base has been shown to be very important. Therefore some suggestions can also be made to firms active in the high-tech service industry. It seems recommended to create a number of conditions facilitating effective decision-

making in the high-tech service innovation process. This can be done, first by selecting flexible decision-makers that do not rigidly stick to one exclusive decision style, and are eager to learn and update their knowledge, in terms of both explicit knowledge and experientially gathered tacit knowledge. Second, firms can improve innovation conditions by developing an open, unrestrained culture. The organized gathering of intelligence in a number of domains, such as technology and customer requirements will increase the openness of the organization to its environment. Companies should also realize that an ‘information system’ or platform that makes the gathered intelligence available to the decision-makers in real-time and in a digestible format is a necessary condition of improving decision-making effectiveness. Decision-makers should also be offered the opportunity to learn as much as possible. Finally, the organization could create decision-making platforms, where experts could make difficult decisions together.

6.4 Conclusion

The dissertation has made a start with the development of a comprehensive theoretical understanding of decision-making under uncertainty under the unique conditions present in the high-tech service innovation process. The various conceptual models that were built were respectively based upon extensive qualitative and quantitative research. Central constructs of the thesis are decision-making effectiveness and task conditions. The flexibility of using appropriate decision-making styles under different circumstances, an integrative view, and the combination of multidisciplinary absorptive capacity *and* regular internal and external updating of the managers were found to be important antecedents of effective decision-making in the innovation

process. The best-adapted decision strategy was found to be a flexible mix of analysis, common sense and active sensemaking. Furthermore managerial commitment to decisions was conceptualized as a decision outcome, with information antecedents different from the information antecedents of the choice outcome. Finally we identified a range of information collection, diffusion and processing related organizational antecedents of effective innovation decision-making. Overall these findings have greatly increased our understanding of the requirements of effective decision-making under extreme uncertainty, as it occurs in the high-tech service innovation process.

6.4.1 Limitations and Suggestions for Future Research

Limitations of each of the studies have been discussed in detail at the end of each chapter. We therefore focus on more general directions for future research in the study of decision-making under uncertainty, service innovation and the information processing perspective on the firm.

With respect to the study of managerial decision-making and its effectiveness under challenging circumstances, we can only stress that research is still in its very early stages. More research is urgently needed, both on a conceptual level and empirically. Concerning conceptual research, to further pursue the multidisciplinary approach we adopted in Chapter Two seems a very promising avenue. By integrating findings from epistemology, neural science, cognitive psychology and research in managerial decision-making a much more complete conceptualization of the phenomenon of decision-making under extremely challenging conditions is possible, than in any of the disciplines separately. In parallel with the developments on a conceptual plane, it will be necessary to conduct empirical research in order to falsify and validate theoretical progress. It seems therefore appropriate to coher-

ently conduct further empirical research in terms of a combination of case study or field research, and experimental studies.

The study of managerial decision-making practice by means of case study research in Chapter Three has proven very useful and productive in terms of theory development. Nonetheless, the developed theory now needs to be refined and operationalized, in order to be objectively validated. As a consequence, there is a need for more research, both in terms of a refinement of the theoretical framework and in terms of the development of measures for the constructs that make up the theoretical framework. It seems highly recommendable to include the social network of the decision-makers in further research, since the network in which they are embedded may play a very important role with respect to the extent to which they are able to reduce uncertainty, and thus their decision-making effectiveness under challenging circumstances. This implies that social network methodology may prove very useful in the further study of managerial performance.

The study we conducted in Chapter Four must be replicated under varying circumstances. A first attempt was made to measure the biasing effects of information overload on two different outcomes of decision-making. In order to obtain more insight in the development of commitment, and the role of information in this development, more experimental research is needed.

Finally, having demonstrated in Chapter Five that the information processing view on the organization can be very successful and productive, more research is needed here too, in order to refine the measurement instruments. Replication in different industries seems very useful in order to determine the scope of the effects we observed. A first attempt was made to study the effects of information use on the initial go-no-go decision in high-tech service innovation. More research is certainly needed in order to develop a better

understanding of the role of information and cognitive styles in the strategic decision process in determining the decision-makers' effectiveness in the selection of projects and the allocation of resources. Here too, we suggest that the process first be studied in detail, by means of case methodology. Furthermore the role the embeddedness of the decision-makers in the knowledge network of the organization plays with respect to the decision-making effectiveness should be explored.

With these suggestions for further research we conclude the dissertation. In the four studies that we have reported in this dissertation we have tried to develop and apply a number of really new perspectives on the highly intriguing phenomenon of 'decision-making under uncertainty'. If we succeeded in producing a number of substantially new insights and in creating opportunities for a productive further exploration of the phenomenon, we may consider this mission accomplished.

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Nederlandse Samenvatting

Inleiding

Wereldwijd spelen informatie- en communicatietechnologie (ICT) een steeds grotere rol in de dienstensector. Niet alleen tijdens de ontwikkeling van nieuwe diensten wordt veelvuldig gebruik gemaakt van ICT, maar ook bij de uiteindelijke levering van de diensten aan de consument spelen deze vormen van technologie een steeds belangrijker rol. Meer en meer bedrijven brengen allerlei hoogtechnologische diensten, in de vorm van ondersteunende, faciliterende of aanvullende diensten, maar ook in de vorm van op zichzelfstaande producten, op de markt. Deze diensten zijn toegankelijk via automaten of terminals (zelfbedieningstechnologie), het internet (e-diensten), mobiele telefoons (m-diensten) of combinaties hiervan. We kunnen hierbij denken aan elektronische bank- en verzekeringsdiensten, elektronische informatievoorziening, elektronische reisboekingen en allerlei vormen van ondersteunende klantendiensten (customer service) etc.

Door razendsnelle technologische ontwikkelingen, vooral in de vorm van miniaturisering van de gebruikte elektronische apparatuur en de snel toenemende bandbreedte en snelheid van datacommunicatie, de snel veranderende behoeften en eisen van de consument, en de globalisering van de markt heerst er in de hoogtechnologische dienstensector echter grote turbulentie. De concurrentie is zeer hevig, waardoor de consument steeds hogere eisen aan de

prijs-kwaliteitverhouding van de aangeboden diensten kan stellen. Bovendien is de levenscyclus van de nieuwe diensten, voornamelijk ten gevolge van snelle technologische ontwikkelingen en de hevige turbulentie in de markt, vaak bijzonder kort. Voortdurende innovatie, enerzijds door het transformeren of incrementeel aanpassen en verbeteren van bestaande diensten, anderzijds door het op de markt brengen van volledig nieuwe producten, is daarom voor veel bedrijven in de elektronische dienstensector van levensbelang. Ook is het regelmatig aanbieden van volledig nieuwe diensten voor veel bedrijven de aangewezen manier om munt te slaan uit het bezit van een bestaande loyale klantenkring, via cross-selling praktijken, en in veel gevallen de enige manier om groei te bewerkstelligen.

Innovatie is dus van levensbelang in de sector, maar het beheren en beheersen van het innovatieproces is geen sinecure en het mislukkingpercentage van nieuwe hoogtechnologische diensten is zeer hoog, terwijl de noodzakelijke investeringen vaak eveneens erg groot zijn. De moeilijkheden beginnen al bij een poging om een antwoord te vinden op de strategische vragen of een bepaalde dienst voor een bedrijf commercieel interessant kan zijn, of de dienst de merkwaarde zal doen toenemen, nieuwe markten zal openen etc. Grote onzekerheid met betrekking tot toekomstige technologische ontwikkelingen, ontwikkeling in de markt, de onvoorspelbaarheid van de innovatiestrategieën van concurrenten en snel veranderende consumentenbehoeften en -gedrag maken het nemen van strategische beslissingen tot het ontwikkelen en op de markt brengen van een nieuwe dienst buitengewoon moeilijk.

Ook nadat een positieve beslissing genomen is om een bepaalde nieuwe dienst in principe te ontwikkelen, moeten er tijdens de productontwikkelingsfase nog veel beslissingen genomen worden op operationeel vlak, die te maken hebben met zaken waarover grote onzekerheid heerst. Dit is opnieuw te wij-

ten aan de enorme dynamiek van de sector. Daarnaast is het ontwikkelen van nieuwe hoogtechnologische diensten een buitengewoon complex en multidisciplinair gebeuren, waarbij ook iedere operationele beslissing vóórrekkende gevolgen heeft.

In de literatuur is al lang een verband vastgesteld tussen de mate waarin het management een effectieve besluitvorming in praktijk brengt en de behaalde bedrijfsresultaten. Wanneer het management het innovatieproces onder controle heeft, door middel van effectieve besluitvorming, mogen we aannemen dat de kans op positieve resultaten, in de vorm van de mate van succes van de nieuwe diensten, ook toeneemt. In de praktijk kan dat bedrijven die hun innovatieproces beter beheersen, door middel van effectievere besluitvorming, ook substantieel concurrentievoordeel opleveren. De vraag rijst dus, hoe men de effectiviteit van de besluitvorming tijdens het innovatieproces in de ICT dienstensector kan verhogen. Dit brengt ons bij de centrale vraagstelling van de dissertatie.

- *Hoe kan de effectiviteit van de besluitvorming in het innovatieproces van op informatie en communicatietechnologie gebaseerde diensten vergroot worden?*

Om de vraagstelling op gepaste wijze te kunnen uitwerken, hebben we haar opgesplitst in vier deelvragen, die we vervolgens in vier afzonderlijke en op zich zelf staande studies behandeld hebben. We brengen verslag uit over deze studies in de hoofdstukken Twee tot en met Vijf van deze dissertatie.

Verband tussen de Taakomstandigheden en de Effectiviteit van Besluitvormingsstijlen

De eerste deelvraag, behandeld in het onderzoek waarover in Hoofdstuk Twee verslag uitgebracht wordt, luidt:

- *Bestaat er een verband tussen de besluitvormingscontext, d.w.z. de taakgerelateerde omstandigheden waaronder de manager beslissingen moet nemen, en de relatieve effectiviteit van verschillende besluitvormingsstijlen?*

In dit hoofdstuk hebben we onderzocht welke besluitvormingsstijlen er in de literatuur onderscheiden worden, onder welke omstandigheden deze besluitvormingsstijlen gebruikt kunnen worden en welke factoren een rol spelen ten aanzien van beperkingen in de validiteit van de op die manier genomen beslissingen. Gebaseerd op het relatieve gebruik van twee cognitieve informatieverwerkingssystemen worden er traditioneel een intuïtieve, een analytische en een semi-rationele besluitvormingsstijl onderscheiden. Gebaseerd op een literatuuronderzoek stellen we in dit hoofdstuk voor om de semi-rationele besluitvormingsstijl uit te splitsen in wat wij genoemd hebben een ‘gezond verstand stijl’ die gepaard gaat met een hoge mate van efficiëntie en een zeer selectief gebruik van informatie enerzijds en een strategische besluitvormingsstijl anderzijds, die gekenmerkt wordt door een intensief gebruik van zowel analytische informatieverwerking als van experiëntiële cognitie.

Vervolgens hebben we de vier stijlen ge-evalueerd met betrekking tot hun relatieve geschiktheid voor gebruik onder verschillende omstandigheden. Ons onderzoek heeft geleid tot het inzicht dat iedere manager gebruik maakt van een combinatie van cognitieve processen, die fundamenteel verschillend zijn in hun informatiebehoefte en de manier waarop ze tot een resultaat leiden. Niet alleen zal een effectieve manager zich door de probleem- en taak-gerelateerde omstandigheden moeten laten leiden bij het kiezen tussen verschillende beslissingsstijlen, maar hij zal zich tevens rekenschap moeten geven van de inherente beperkingen die de onderliggende cognitieve processen aan het gebruik van de verschillende stijlen opleggen. Samenvattend kunnen

we met betrekking tot een valide gebruik van de vier geïdentificeerde stijlen zeggen, dat:

- Een overwegend rationele beslissingsstijl gerechtvaardigd is wanneer er voldoende ondubbelzinnige en complete informatie aanwezig is, en het beslissingsprobleem een grote mate van overzichtelijkheid bezit.
- Een overwegend op common-sense gebaseerde beslissingsstijl gerechtvaardigd is wanneer het beslissingsprobleem routinematig en niet extreem belangrijk is, er voldoende informatie is en er redelijke tijdsdruk heerst.
- Een overwegend op het gebruik van intuïtie gebaseerde beslissingsstijl gerechtvaardigd is, wanneer het beslissingsprobleem relatief routinematig is, maar weinig expliciet.
- Een overwegend strategische beslissingsstijl de beste oplossing is, wanneer het beslissingsprobleem ongestructureerd en niet routinematig is, er een combinatie van in sommige opzichten weinig, en in andere opzichten veel maar dubbelzinnige informatie beschikbaar is, en wanneer er relatief snel relatief grote veranderingen in de omstandigheden optreden.

Ook werden er in dit hoofdstuk verschillende factoren geïdentificeerd die de validiteit van het gebruik van de verschillende stijlen modereren, zoals tijdsdruk, turbulentie, en de aanwezige ervaring.

Antecedenten van Effectieve Besluitvorming in Hoogtechnologische Diensteninnovatie

In moderne innovatieprocessen, waar de besluitvormingsautoriteit sterk gedecentraliseerd is, speelt de productmanager een zeer belangrijke rol in het

succesvol ten uitvoer brengen van individuele innovatieprojecten. Er is erg weinig bekend met betrekking tot de factoren die een rol spelen in het tot stand komen van effectieve besluitvorming op het niveau van de productmanager. In het onderzoek waarover we in Hoofdstuk Drie verslag uitbrengen hebben we derhalve de volgende twee deelvragen behandeld:

- *Wat zijn precies de taakgerelateerde omstandigheden van de managers die het innovatieproces in de hoogtechnologische dienstensector moeten beheersen en welke factoren hebben de sterkste invloed op de effectiviteit waarmee zij het proces beheersen?*

En vervolgens:

- *Welke antecedenten van snelle en effectieve besluitvorming kunnen we identificeren in het hoogtechnologische dienstverleningsinnovatieproces? Welke factoren in verband met het gebruik van informatie, de besluitvormingsstijl en de besluitvormingsarchitectuur van het bedrijf dragen bij tot een hoge mate van effectieve besluitvaardigheid?*

We hebben deze vragen onderzocht door middel van een uitgebreide casusstudie, die we uitgevoerd hebben in de Nederlandse mobiele telecommunicatiedienstensector. De belangrijkste bevinding is, dat besluitvorming in het diensteninnovatieproces gehinderd wordt door een combinatie van onzekerheid, complexiteit en tijdsdruk. Managers gaan in de regel met deze factoren om, door middel van een flexibele instelling ten aanzien van het gebruik van verschillende beslissingsstijlen. Ze kunnen de verschillende denkstijlen echter pas goed inzetten, wanneer ze een heldere voorstelling hebben van de nieuwe te ontwikkelen dienst. Deze voorstelling bestaat uit inzicht in de raakvlakken van de nieuwe dienst met de eigen organisatie, de consument, de technologie en de regulerende wetgeving en industriestandaarden. De expertise die nodig

is wordt voornamelijk verkregen door intensieve ervaring in de productmanagersfunctie.

Besluitvorming: Keuze en Engagement, het Probleem van Informatieovervloed

Een belangrijk probleem, dat zich in moderne managementpraktijk veelvuldig voordoet is het voorkomen van een overvloed aan informatie. In Hoofdstuk Vier, waarin we over een besluitvormingsexperiment rapporteren, zijn we daarom vervolgens dieper ingegaan op de volgende deelvraag:

- *Welke rol speelt een overvloed van informatie bij het tot stand komen van effectieve besluitvorming?*

In dit hoofdstuk hebben we ons in eerste instantie gebogen over de vraag wat precies als de uitkomst van een besluit gezien mag worden. In de gangbare besluitvormingsliteratuur wordt besluitvorming algemeen opgevat als een keuze. Wij stellen voor om de uitkomst van een beslissing niet eenzijdig als een keuze op te vatten, maar als een keuze enerzijds en de ontwikkeling van een bepaalde mate van engagement ten aanzien van die keuze anderzijds. Op grond van bevindingen gerapporteerd in bestaande escalatieliteratuur argumenteren we, dat beide uitkomsten van het beslissingsproces van belang zijn voor de effectiviteit van de besluitvorming. Een keuze kan juist en onjuist zijn, maar de effectiviteit van besluitvorming kan zowel door een grote mate of zelfs escalatie van het engagement bij een foutieve keuze, of een zeer geringe mate van engagement bij een ‘correcte’ keuze toch danig in gevaar gebracht worden. Vervolgens hebben we in de vorm van een besluitvormingsexperiment bepaald in hoeverre de beide uitkomsten bepaald worden door verschillende vormen van informatie. Uit ons onderzoek is gebleken, dat verschillende vormen van informatie verschillende effecten hebben op de

keuze en de mate van engagement. Informatie die niet relevant is voor de uitkomst van de keuze van de manager, maar die wel zijn moreel beïnvloedt, heeft weldegelijk invloed op de grootte van het initiële engagement waarmee de manager zijn beslissing omringt. Op grond van deze observaties stellen we voor om de literatuur met betrekking tot fouten (bias) in de rationele besluitvorming uit te breiden. Irrationaliteit kan blijkbaar niet alleen een rol spelen in de totstandkoming van de keuze, maar evenzeer in de totstandkoming van het initiële engagement. Uit de bevindingen van het onderzoek waarover we in dit hoofdstuk gerapporteerd hebben valt af te leiden, dat de besluitvormer precies bij het ontwikkelen van engagement ten aanzien van een keuze in zekere mate beïnvloed worden door factoren die irrelevant zijn voor het beslissingsprobleem. Een belangrijke implicatie is, dat de manager zich rekenschap dient te geven van het feit dat zijn engagement ten aanzien van bijvoorbeeld een bepaald innovatieproject ten dele bepaald wordt door factoren die niet rechtstreeks met dat innovatieproject te maken hebben, zeker voor zover de beslissingen in verband met dat innovatieproject genomen werden onder omstandigheden van informatie ‘overload’ en grote tijdsdruk. Bij het nemen van vervolgbeslissingen is daarom enige reflectie op zijn plaats.

Succesfactoren in het Innovatieproces in de Hoogtechnologische Dienstensector

Nadat we in de Hoofdstukken Twee tot en met Vier vooral gekeken hadden naar factoren die de effectiviteit van de besluitvorming bepalen op het niveau van de individuele manager, hebben we in Hoofdstuk Vijf vooral gezocht naar factoren gerelateerd aan de verwerking van informatie binnen de organisatie, die de effectiviteit van de besluitvorming in het innovatieproces beïnvloeden. De deelvraag die we in dit hoofdstuk behandeld hebben is de volgende:

- *Welke factoren, gerelateerd aan de informatieverwerking, beïnvloeden de waarschijnlijkheid dat een nieuwe dienst een succes wordt, door hun effect of de effectiviteit van de besluitvorming tijdens het innovatieproces?*

We hebben deze vraagstelling voor twee verschillende fases van het innovatieproces onderzocht. In eerste instantie hebben we gekeken naar de fase waarin op strategisch niveau beslist wordt over het al dan niet commercialiseren van een productvoorstel. Vervolgens hebben we onderzocht welke factoren een rol spelen tijdens de ontwikkelingsfase van de nieuwe dienst. We hebben op grond van een uitgebreide literatuurstudie een aantal proposities opgesteld en op grond van deze proposities een theoretisch model van het effect van de informatieverwerking op de effectiviteit van de besluitvorming geconstrueerd. Dit model hebben we vervolgens geschat op grond van empirische data die we verzameld hebben in een wereldwijd uitgevoerde enquête. De belangrijkste bevindingen uit dit onderzoek zijn enerzijds de constatering dat een informatieverwerkingsperspectief buitengewoon vruchtbaar kan zijn voor het onderzoek naar succesfactoren in diensteninnovatie en anderzijds de identificatie van een aantal factoren die een positief effect hebben op de slagingskans van nieuwe diensten. Succesfactoren werden in dit onderzoek gevonden in het aannemen van een strategische houding ten aanzien van de go-no-go beslissing, het gebruik van zowel interne informatie, alsook van resultaten van marktonderzoek tijdens die beslissing en tenslotte de participatie van topmanagers in die strategische beslissing. Met betrekking tot het operationele deel van het innovatieproces mogen we op grond van deze studie concluderen dat gestructureerde informatievergaring op het gebied van veranderingen in consumentenbehoeften en -gedrag, alsmede op het vlak van de technologie een positieve bijdrage leveren. Deze positieve bijdrage wordt

gemedieerd (mediated) door een open communicatieklimaat in de organisatie. De mate waarin de managers ervaring hadden in hun werk vertoont geen positief verband met het succes van innovaties, maar de mate waarin zij conferenties en zowel interne als externe seminars bezoeken wel. Ook werd vastgesteld, dat bedrijven waar informele communicatie een belangrijke rol speelt en gestimuleerd wordt effectiever innoveren. In tegenstelling tot wat in de meeste literatuur gesuggereerd wordt, vonden we in onze data een significant negatieve correlatie tussen innovatiesucces en de mate waarin een bedrijf competitieve informatie vergaart. Een voorzichtige implicatie is, dat bedrijven zich wellicht niet al te veel moeten aantrekken van wat de concurrent uitvoert, maar des te meer moeten luisteren naar hun (potentiële) klanten: d.w.z. voldoende middelen aanwenden om hun innovatiestrategie klantgericht te maken.

Conclusie

De verschillende studies die in het kader van het proefschrift werden uitgevoerd hebben aangetoond dat een informatieverwerkings- en besluitvormingsperspectief op het diensten innovatieprobleem zeer vruchtbaar kan zijn. We hebben in Hoofdstuk Vijf ook empirisch aangetoond, dat er een significant verband bestaat tussen verschillende factoren gerelateerd aan informatieverwerking en innovatiesucces. Verder hebben we met behulp van een scala aan methodes op verschillende niveaus inzicht verworven in factoren die de effectiviteit van de besluitvorming in het innovatieproces bij leveranciers van hoogtechnologische diensten beïnvloeden.

Gebleken is, dat we die factoren onder andere kunnen vinden in de expertise van de besluitvormers, het gebruik van verschillende soorten informatie en de mate waarin de besluitvormer zijn cognitieve stijl aanpast: enerzijds

aan de eisen van de taakgerelateerde omgeving, maar anderzijds ook aan de aanwezigheid van valide informatie en kennis. Tevens hebben we moeten constateren dat het bedrijfseconomisch onderzoek naar besluitvorming onder onzekerheid en de factoren die een rol spelen met betrekking tot de effectiviteit ervan op veel vlakken nog in een beginstadium verkeert. We hebben daarom in de verschillende hoofdstukken een aantal gebieden aangegeven, waar ons inziens dringend behoefte is aan vervolgonderzoek. Wil dit onderzoek bruikbare inzichten opleveren voor de verbetering van de effectiviteit van besluitvorming, dan zal zich dit moeten richten op de bestudering van besluitvormingsprocessen onder realistische omstandigheden.

Suggesties voor Vervolgonderzoek

Het onderzoek naar de besluitvorming onder onzekerheid staat nog in de kinderschoenen en er kan en moet in deze wetenschap grote vooruitgang geboekt worden door verder onderzoek. Met name willen we noemen de vruchtbare combinatie van onderzoek naar besluitvorming in de neurofysische wetenschappen, cognitieve psychologie, kentheorie en de managementwetenschappen. Dit lijkt een traject dat kan leiden tot een beter begrip van het mechanisme van de besluitvorming onder onzekerheid en van de factoren die de effectiviteit van managers onder zeer moeilijke omstandigheden bepalen. Om tot een omvattende wetenschap van de besluitvorming te komen dient er zowel op theoretisch vlak als, bij voorkeur hiermee verbonden, op empirisch gebied onderzoek verricht te worden. Het lijkt vooral zinvol, om onderzoeksvragen in een combinatie van veldonderzoek en laboratoriumonderzoek te onderzoeken.

In Hoofdstuk Drie van deze dissertatie is gebleken hoe productief de casusmethodologie kan zijn bij het in detail bestuderen van besluitvormingsprocessen en de gerelateerde theorievorming. De gevormde theorie dient echter

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verfijnd te worden en kan bovendien verder verrijkt worden met inzichten uit andere bedrijfstakken. Daarnaast lijkt het ook aangewezen om aan de hand van de ontwikkelde constructen meetinstrumenten te ontwikkelen, die een empirische validering van de theorie mogelijk maken.

Het onderzoek uit Hoofdstuk Vier van deze dissertatie moet als een eerste aanzet gezien worden in het onderzoek naar de ontwikkeling van engagement en de rol die informatie in deze ontwikkeling speelt. Meer empirisch onderzoek is nodig om de theorie verder te ontwikkelen en het geldigheid van de vastgestelde relaties onder variabele omstandigheden te onderzoeken. Tevens geeft het onderzoek in dit hoofdstuk de aanzet tot het onderzoeken van de rol die een overvloed aan informatie heeft op het besluitvormingsgedrag van managers. Hier stellen we voor, dat verder onderzoek dient aan te tonen in hoeverre informatieovervloed in de dagelijkse managementpraktijk de besluitvorming, of het hieraan gerelateerde engagement, negatief beïnvloedt.

Tenslotte heeft het onderzoek in Hoofdstuk Vijf aangetoond hoe zinvol het innemen van een informatieverwerkingsperspectief op de organisatie kan zijn bij de bestudering van succesfactoren in diensteninnovatie. Ook dit onderzoek heeft geleid tot een aantal pistes voor vervolgonderzoek. Met name de go-no-go beslissing dient verder onderzocht te worden. Door middel van casusonderzoek zou een gedetailleerd beeld gevormd kunnen worden van het beslissingsproces, alsmede van de factoren die de uiteindelijke selectie bepalen. Met behulp van sociale netwerkmethodologie zou de inbedding van de besluitvormers in het informatienetwerk van de organisatie in beeld gebracht kunnen worden. Ook de rol die verschillende besluitvormingsstijlen spelen bij deze strategische beslissingen zou verder onderzocht moeten worden, omdat informatie in deze beslissing een minder grote rol lijkt te spelen bij de reductie van onzekerheid en het tot stand brengen van een effectieve besluitvorming dan in operationele beslissingsprocessen.

Curriculum Vitae

Allard Cornelis Robert van Riel was born on January 10, 1963 in Krommenie, currently Zaanstad, in the Netherlands. After the completion of his secondary school at the Murmellius Gymnasium in Alkmaar, he studied Chemistry at the University of Amsterdam for two years and then moved to the study of Philosophy at the Central Interfaculty of the University of Amsterdam. He specialized in the History of Western Philosophy and Metaphysics and Epistemology and obtained his Master's degree in Philosophy in 1988. His Final Thesis was concerned with the Logic of Language in the Work of Ludwig Wittgenstein. After having been active in Educational Bookselling and Publishing for several years, he started part-time teaching various courses in International Business and Organizational Behavior at an MBA level at the United Business Institutes (UBI) in Brussels, Belgium, and took care of part of the course Organization Theory at the University of Tilburg. He permanently quit the Educational Publishing Business in 1998, to become a Teaching Assistant in the Department of Strategy and Logistics, of Maastricht University. After four months he started his PhD research in the Department of Marketing and Marketing Research of the same university in 1999. His current research interests include decision-making under uncertainty, and innovation in electronic services, both from a consumer and from a managerial perspective. He published articles in the Journal of Service Re-

search and the International Journal of Service Industry Management, and furthermore contributed several chapters in books and conference proceedings.

Allard Cornelis Robert van Riel werd op 10 januari 1963 geboren te Krommenie, het huidige Zaanstad. Na het voltooien van zijn middelbare schoolopleiding aan het Murmellius Gymnasium te Alkmaar, waar hij VWO - β volgde, studeerde hij twee jaar scheikunde aan de universiteit van Amsterdam (UvA). Vervolgens begon hij aan de opleiding wijsbegeerte, die hij in 1988 voltooide. Hij specialiseerde zich in de Geschiedenis van de Westerse Wijsbegeerte en Metafysica en Kenleer. Zijn doctoraalscriptie had betrekking op de Logica van de Taal bij Ludwig Wittgenstein. Nadat hij verschillende jaren actief was geweest in de boekenbranche en in het academische uitgeversbedrijf, doceerde hij aan de MBA opleiding United Business Institutes (UBI) in Brussel verschillende vakken m.b.t. International Business en Organizational Behavior, in parttime. Nadat hij aan de KUB assisteerde bij het onderwijs van het vak Organisatieleer, besloot hij de academische uitgeverswereld definitief te verlaten en werd hij in 1998 toegevoegd docent aan de Universiteit Maastricht, in de sectie Strategie en Logistiek van de vakgroep Managementwetenschappen. Na vier maanden startte hij zijn carrière als AIO bij de sectie Marketing en Marktonderzoek van dezelfde vakgroep. Zijn huidige onderzoeksbelangstelling gaat vooral uit naar besluitvorming onder onzekerheid, innovatie en elektronische diensten, zowel vanuit consumentenperspectief als vanuit een management perspectief bekeken. Hij publiceerde artikelen in het Journal of Service Research, in het International Journal of Service Industrie Management, het Jaarboek 2002 van Ontwikkelingen in het Marktonderzoek, het Jahrbuch Dienstleistungsmanagement 2002 en in verschillende Conference Proceedings.

Appendix

NEW PRODUCT DECISION-MAKING EXPERIMENT 2001

Maastricht University

INSTRUCTIONS (Please Read Carefully)

Thank you for participating in our decision-making experiment. As explained in the attached information, you are supposed to assume the role of a decision-maker in a publishing firm that will make a number of resource allocation decisions to the best of his/her ability. The decision-making experiment is in no way competitive: there is no best solution. Please **read the full instructions** before starting.

1. Please consider the Information with which we supplied you **in the following order**:

- Description of You and your Job (page 3)
- Description of the Company (page 3-4)
- Description of the Assignment (page 5)
- Description of the New Product (page 6)
- Description of the Business (page 7)
- Description of the Market (page 8-9)

- Extra Information (separate package will be handed out)¹
2. After you will have read all information, we will ask you to make a number of resource allocation decisions.
 3. After making these decisions you will be asked a number of questions about the decision-making process. They will have the following format:

EXAMPLE:

Statement:	Disagree Agree 1 2 3 4 5 6 7
Bill Clinton was a Good President	0 0 0 0 0 0 0

¹This refers to the packages containing the colored e-mail messages

Jan Smith: Description of Yourself and your Job

Your name is Jan Smith; you are 32 years of age, and unmarried. Your mother is Dutch and your father American. You are based in Maastricht, at the European Headquarters of **GlobEdo Inc.**, a US-based global educational publishing company. You are currently the European Director of Sales and Marketing for GlobEdo Inc, reporting to the Vice President of International Sales in the U.S. You were hired for this job two years ago. Before assuming this position, you have been working for three years as a very successful sales representative for GlobEdo Inc. in the United States, where you have been elected rookie of the year in your first year. Before that, you studied English Literature at the University of York. You have won numerous sales awards and are a very hard worker. In your current position, based on your knowledge of the market and on your in-depth product knowledge, it is your personal responsibility to compose a highly competitive and successful product portfolio for Europe, Africa and the Middle East, present and defend your budgets at the International Division of GlobEdo Inc. Second part of your job is to make the necessary resource allocations for successful marketing, distribution and sales efforts in Europe, Africa and the Middle East. You have a team of seventeen regional sales managers reporting to you. They work with their sales teams all over Europe, Africa and the Middle East and are working hard to generate sales. Sales figures and costs are both important topics on your yearly appraisal, as you receive a bonus-plan based on average profit generated in your market. In general the sales specialists that work in your territory have a higher education background. You are aware that they lack specific sales training and you think that next year you will spend substantial resources on improving their sales techniques.

GlobEdo Inc.: Description of the Company

GlobEdo Inc. is an originally US-based, currently globally operating educational publishing company. The company evolved from a highly specialized scientific publisher, basically only publishing manuscripts from Nobel Laureates, some fifty years ago, to a global player in the educational publishing industry. They currently publish in twenty languages. Products vary from English as a Second Language, via all sorts of Textbooks for Higher and Professional Education, to Professional Training books in many different subject areas. Subject Area's vary between Psychology, Medicine, Computer Science, and Engineering to Business and Economics. GlobEdo Inc. is currently a medium sized company, employing some 800 people worldwide. Although the company has grown relatively fast in the seventies and eighties, it has retained its family owned style. They have offices in over fifty countries, and a very well organized distribution system, with warehouses on all continents. The company does not own any printing facilities, but makes use of many different professional printers, spread over the globe. High quality materials are printed in the US and Europe. If the quality of the printing is not important, the company employs printers in the Far East. The company has a relatively decentralized product policy, adapted to a very heterogeneous market.

The US division produces most best selling books, generally in full color and highly professional looking, as they have the largest editorial and production budgets. The production of some of the more successful textbooks costs between 100.000 and more than two million dollars each. The production of such a textbook can take more than a year. Not only the textbook is developed during that time, but also a rich array of supplementary materials, both for students and lecturers. Think of personalized book-specific web sites, slide shows, multimedia materials, test banks, instructor's manuals etc.

The average sales of such a textbook are between 10.000 and 40.000 to 50.000 copies a year. The pricing is currently around \$ 75.00 in the US, and around 50.00 in Europe.

Sales have grown on a worldwide basis by approximately ten percent annually for the last couple of years, but margins have shrunk alarmingly. A very large media group has acquired the company recently. The new owners insist on double-digit growth over the full product line. Many employees think that in an educational business, where quality is very important, it will be very difficult to reach this growth figure in a conventional way. It may be needed to move into new niche markets, where there is less competition. Although the supplementary package, accompanying textbooks, is taking a more and more important position, Glob Edo is still very much a book-centered publisher. Little effort has been put into the development of stand-alone multimedia products, as the company policy has always been that book production is their core competence. Nonetheless, some editors and many of the Sales and marketing Staff feel that the company policy on this point is too conservative. They would rather move forward, as they call it, and start shifting from a book centered core competence to an educational contents core competence, that would allow them to move fast into new media and capitalize on their editorial expertise and emerging demand. Overseas offices on all continents produce their own, regionally adapted books, as well as original products. They are responsible for the selection, marketing, sales and distribution of internationally produced books.

There is a lot of pressure from the US division to sell their products, as for their turnover they count on about 40% of international sales. There is, however, little enthusiasm to make adaptations to the products for international markets. The editors consider it a very costly matter and do

not really support the overseas divisions at this point. Over the years, the Boston-based company has built a very strong general reputation with its customers in terms of quality and reliability. They have established a generally well-motivated, loyal workforce. There is a rather strong and distinct company culture that has always united employees from different divisions, backgrounds and countries. Worldwide employees meet at least twice a year at the US-based Annual Sales Meeting and the National Sales Meeting. If business is booming, the company treats its employees with parties.

Your Assignment: Decision Making

After studying the provided information package, consisting of the description of the company, the market, your job, the new product and the e-mails, you will have to make the following decisions: Should GlobEdo Europe introduce the radically new product 'Working Model Web-based Educational Edition' to the European, African and Middle Eastern Market or not and if so, how much should relatively be invested in the marketing, sales, distribution and support of the new product.

Like every managerial decision, the decision to include Working Model Web Based Educational Edition in your Product Portfolio needs to be made very quickly and independently. There is no time to wait for the first sales-results from the US. If the product is to be introduced in Europe, for Strategic reasons, introduction to market must be simultaneously with the US. Production and Distribution managers in the US have already called you several times; to insist you make a decision soon, as they need your forecasts yesterday rather than today. They need your forecasts in order to negotiate with the alliance partners and schedule production and distribution. They need to know how many manuals they need to print and in which language. As they will centrally organize the training sessions, they

must know how many people will attend etc. You know for sure that no other company has offered anything similar on the educational market and your first mover advantage could be lost soon. However, you also realize that it is rather unpredictable what a green light from you would imply precisely. If Working Model Web based Educational Edition should be successful, it might require a substantial share of your resources. There is an undeniable and serious risk of failure, but if the product is successful, potential profits could be very important and a large new market potential would be opened up, which would certainly have implications for your position in the company. The other way round too, probably...

Working Model Web Edition New Product Information Sheet

Product ID: 0-201-898898-9 (2001)

Authors: P.D. James (MIT), I. Banks (KR), and J. Bond (GE)

Technical Requirements: IBM Compatible, Win 98/2000, Proc. Pentium Min. 550 Mhz., 128 MB RAM, Network or ISDN or ADSL Internet Connection

Educational Subscription Price: 150 USD/Per Annum (Domestic), 100 USD/Per Annum (Int'l)

Cross-sold to users of: Engineering Mechanics, Dynamics, Statics, University Physics, etc.

Website: <http://www.workingmodel.com/>

This new product is a result of a triad technology alliance between GlobEdo Inc., Knowledge Revolution Inc., a small Engineering Solutions Company, producer of the revolutionary motion simulation software Working Model © and Supernet Inc. a global Application Service Provider.

The new product is a Web based Educational Version of the revolutionary Professional Simulation and Motion Analysis Software "Working Model", as it is used in many engineering Companies in the US, like e.g. Boeing. Compared to the original version, retailing for about \$ 27,000, the Educational Web based Version is only limited in the amount of moving objects that can be analyzed. Subscription to the Web based Educational Version of Working Model will cost about \$150 per annum in the US market and about \$ 100 per annum in the European Market.

NB: this is a radically new type of product. This is especially true for GlobEdo Inc. The Company has its core competencies in producing and marketing best-selling global, pedagogically well-developed traditional textbooks for Higher Education (Colleges, Universities). Although the product is complementary to existing products and potential customers for the new product are familiar, the existing Sales Force has no previous experience in selling web-based software services.

Product Strengths:

This Web based multimedia product allows the user to build and analyze complex dynamic mechanical systems on any desktop computer that is connected to the Internet via a high-speed ISDN or ADSL connection. The unique combination of the revolutionary simulation software, an extremely user-friendly User-Interface with a unique set of interactive tutorials make this product an absolutely radical innovation.

Working MODEL Web Edition has interfaces to many of the most common mathematical packages, like Mat Lab ©, Mathematica © and MS Excel ©. Working Model, Web Edition includes an enormous library of pre-defined components, which can be used to build simulations. GlobEdo Inc. has designed a pedagogically unequalled workbook and interactive tutorials with

the software. Together they form a sound, innovative learning system for a very complex topic.

Known Product Weaknesses:

The software assumes the use of State of the Art computers, minimally equipped with Pentium III 550 MHz, plus a very fast, high-bandwidth Internet connection. These are not yet available in most Educational Institutions in Europe. However, this situation is changing rapidly in a number of countries.

Working Model is basically non-metric (uses Imperial measures, like Inches, Feet, Pounds), although equations in any unit system can be used. The original software is not yet well known in Europe.

The Higher Education Publishing Business

Publishing for Higher Education has become big business. The industry structure has evolved from a large number of idealism-driven amateur-like nationally or regionally focused small businesses twenty years ago, to a limited number of highly organized and streamlined professional publishing companies now, which bitterly compete for a rather stagnant global market. Increasing standardization in education policies on a worldwide scale has allowed the production of a limited number of global educational products that could at least in principle be adopted on a global scale, although in many cases the standardization is still in a beginning phase.

A large market segment is formed by first and second-year courses, in Universities and Colleges, where enrollments are relatively high. The competition in this market segment is at its fiercest, although competition in the industry in general is fierce; there are, however, also many elective courses that have a global market large enough for best-selling textbooks. There is strong demand from university and college lecturers for state of the art prod-

ucts, incorporating the latest available knowledge and technology on the one hand. Conservatism reigns on the side of school administrators. This leads to a strange unbalance between forecasted demand for innovative products and actual demand. This implies that investments in radically new products are generally very high, whereas the risk of failure is high as well, because most competitors are fighting for the same, rather well known opportunities and niches in the market.

The major players in the Global Textbook Market are three well-established US-based Companies. They all publish very high quality educational materials supported by multimedia packages, which are reasonably well suited to the European Market. At the same time there are a few much smaller European Publishers. They are probably too small to make the investments necessary to produce a competing product of the same quality. However, there obviously exists a market opportunity in the Educational Software Market and it could well be that Software Companies are developing competing products. Other alliances between publishers and software companies, like the alliance between Knowledge Revolution and GlobEdo cannot be excluded. They would, however need to cooperate with the publishers, it is generally assumed, as they do not possess the pedagogical expertise and reputation necessary in the domain of educational publishing.

Market Opportunities:

This is the first Engineering Mechanics Simulation package that becomes available for the European Educational Market. There is strong demand for similar software packages that help the student discover complex and notoriously difficult subject matters like Dynamics, in an entertaining and interactive way. Dynamics is taught in very similar ways all over the world. Every engineering student must take courses in Engineering Dynamics. The

total market potential is very large. GlobEdo is already an important player in the traditional Engineering Dynamics Textbook market, having a market share of 60% in the US and 30 % in Europe: 25.000 copies of the best-selling ‘Engineering Mechanics, 10th edition’ book are sold in Europe alone, on a yearly basis.

The new product could easily be sold as a supplement to existing textbooks, as well as a stand alone educational tool. It can be foreseen, that many extensions will be made available for specific topics, as Knowledge Revolution already has many professional extensions available for different industries. This would open up an enormous market. Also, the basic simulation technology could be used in other domains than Engineering. Simulation is recognized as a very good educational tool in many scientific areas like Business, Chemistry, Physics, and Astronomy etc.

Market and other Threats:

Other, possibly Europe-based, publishers may come out soon with entirely European Versions, that may need less strong computers, have metric units and are based on professional packages that are widely spread in Europe. GlobEdo Inc. European division currently does not have the resources to produce such an adapted European version, as this is very expensive and would require long term investments as well as strategic alliances with technology providers. It cannot be denied, that editorial expertise at GlobEdo Inc. is concentrated in the US.

On the other hand, there is also uncertainty about the following developments in the European Market: Will schools and universities continue using educational software in English throughout the EU? As for the Colleges where a large part of the market is, there are voices that software will need to be in the teaching language. Trends exist to translate and adapt

International Educational Material to local languages. This consideration may keep European publishers from developing a European version for some time.

The educational program of many universities is changing and standardization throughout the EU is increasing. The course Engineering Dynamics, where the Working Model Web based Student Edition software could be used, might move up from the first year to the second year. This would have serious implications for the size of the market. First year students buy obligatory material such as books much more faithfully, than second year students. Additionally, for second year materials, there is a flourishing second hand market. This would obviously not impact the subscription rates to Web based Services such as Working Model Web based Student Edition.

End of Information Package