

SEARCH STRATEGIES FOR DISCONTINUOUS INNOVATION: THEORETICAL FINDINGS AND PRACTICAL RELEVANCE

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ABSTRACT

This paper reviews recent research in the search for discontinuous innovation in an integrative manner. Its aim is to systematize existing search strategies into a conceptual framework and analyze their practical relevance and utilization on a broad empirical basis. To this end, a theoretical framework based on systems theory that integrates existing contributions and that could serve as a synopsis of search strategies for discontinuous innovation is proposed. In our empirical study of 92 German enterprises, we find that cooperative strategies with defined partners are both relevant and widely applied. A cluster analysis serves to identify three different organizational patterns. This finding indicates that German organizations make use of either unsystematic, focused, or diversified search strategies.

The survey for this research was conducted under the auspices of Prof. Dr. Kathrin M. Möslin (Academic Director of CLIC Center for Leading Innovation and Cooperation at HHL Leipzig Graduate School of Management) and the Chamber of Commerce and Industry in Leipzig (IHK). The authors gratefully acknowledge the financial support of the IHK, the individuals who participated in the survey and invaluable comments of blind reviewers.

INTRODUCTION

The pivotal role of innovations for an organization's competitiveness has been beyond controversy for a long time.¹ However, in the current environment of shortened product cycles, constant cutthroat competition, and complex organizational structures, the speed of change has risen dramatically.² In this context, numerous authors stress the notion of the end of incrementalism.³ Organizational survival therefore depends upon the ability to initiate fundamental – and thus discontinuous – innovations to counter shrinking profit margins and to secure a competitive advantage on a long-term basis.⁴

Discontinuous innovation is defined here as a fundamental – and often unexpected – change of system variables and/or their interaction structure. It is often expressed in a high degree of novelty in technology, business systems, or market positioning.⁵ A discontinuous innovation breaks with existing approaches and leads to new technological trajectories or customer needs.⁶

However, the early phase of the innovation process, the search for promising ideas, has been given less attention, despite the fact that – as Katila/Ahuja have already pointed out – the method of searching can affect the innovation potential of an enterprise.⁷ Available publications on the search for discontinuous innovations mostly review specific strategies based on individual case studies or provide a simple catalogue of recommended approaches –

¹ C.f. e.g. SCHUMPETER, J. A. (1934), p. 100f. and 111ff.

² C.f. DEEG, J. (2005), p. 7; SCHLEGELMILCH, G. (1999), p. 66. BETTIS/HITT speak of the “new competitive landscape”. C.f. BETTIS, R. A./ HITT, M. A. (1995), p. 7ff.

³ C.f. e.g. FOSTER, R. N./KAPLAN, P. (2001), p. 291f.

⁴ C.f. HAMEL, G. (2000), p. 13f.; FOSTER, R. N./KAPLAN, P. (2001), p. 291f.

⁵ C.f. DAMANPOUR, F./GOPALAKRISHNAN, P. (1999), p. 65; KRIEGER, A. (2005), p. 14; SCHLAAK, T. M. (1999), p. 121ff.; SCHUH, G. (2001), p. 63. A system is a classified and distinguishable entity of elements. C.f. RÜEGG-STÜRM, J. (2002), p. 17.

⁶ C.f. UTTERBACK, J. M. (1994), p. 200.

⁷ C.f. KATILA, R./AHUJA, G. (2002), p. 1189ff.

without a conceptual basis.⁸ The identification of discontinuous innovation is sometimes even characterized as an unpredictable, quasi-ingenuous coincidence.⁹

Search strategies are behavioral plans for the first phase of the innovation process. They represent methods for directly and indirectly scanning the environment for (internal and external) weak signals.¹⁰ Usually, this is done without prior knowledge about the conspicuities to be found. Search strategies therefore enable enterprises to systematically track the environment within and outside defined fields of interest and to avoid a selective perception.¹¹

The aim of this paper is to systematize search strategies for discontinuous innovations into a conceptual framework and to measure their relevance and utilization empirically. The objective is to deliver an integrative contribution that consolidates existing research findings and subsequently mirrors the relevance and utilization of the various search strategies from the practitioner's point of view.

Our paper is divided into six sections. After the introduction, the paper delivers a conceptual framework of search strategies for discontinuous innovation based on systems theory and briefly sums up recent research findings. The design and results of our empirical study are presented in the third and fourth sections. The paper ends with a discussion and an outlook for future research needs.

⁸ C.f. e.g. BESSANT, J. (2005), p. 41; LYNN, G. P./MORONE, J. G. et al. (1996), p. 8ff.

⁹ C.f. e.g. GARCIA, R./CALANTONE, R. (2002), p. 127.

¹⁰ C.f. LICHTENTHALER, E. (2002), p. 37.

¹¹ C.f. SCHLEGELMILCH, G. (1999), p. 77; TIDD, J./BESSANT, J. et al. (2005), p. 349f.

SEARCHING FOR DISCONTINUOUS INNOVATION – A THREE-DIMENSIONAL APPROACH

Conceptual Background

Numerous search strategies for discontinuous innovation have already been identified. Recently published contributions have especially expanded the state of knowledge on this subject.¹² However, the diversity of these contributions makes it hard to distinguish if the publications are actually addressing specific search strategies for discontinuous innovations, offering general methods of stimulating ideas (e.g. creativity techniques, such as brainstorming), or merely presenting organizational enablers (e.g. a culture that embraces change and encourages risk-taking). Additionally, it can be observed that most publications focus on certain aspects or individual search strategies.¹³ Those publications that try to deliver a synopsis of search strategies concentrate on simply enumerating various approaches without providing a broad empirical or conceptual basis or demonstrating implementation options.¹⁴ Furthermore, these publications often mix methods and objects of search strategies; their summaries are therefore not mutually exclusive and give the impression of an eclectic rather than a systematic research approach.

One major reason for this research gap is that developing a structure to systematize search strategies for discontinuous innovation inevitably entails a trade-off between ensuring diversity of perspectives and reducing complexity.¹⁵ From an economic point of view, this

¹² An exemplary reference is the LONG RANGE PLANNING's special edition in February 2004.

¹³ C.f. DUYSTERS, G./DE MAN, A.-P. (2004), p. 49ff.; LYNN, G. P./MORONE, J. G. et al. (1996), p. 8ff.

¹⁴ E.g. BESSANT et al. advise using "technological antennae to seek out potential new technologies" without specifying the elements of such a strategy or how to implement it. Vide BESSANT, J./LAMMING, R. et al. (2005), p. 1373 and similar in TIDD, J./BESSANT, J. et al. (2005), p. 407.

¹⁵ C.f. DAY, G. P./SCHOEMAKER, P. J. (2005), p. 132ff. DEBUS additionally notes that without decision premises or context control, only a crisis would force organizations to look beyond their current comfort zone. C.f. DEBUS, C. (2002), p. 130.

simply equates into an arithmetic problem of finding the optimum at which expanding and intensifying the scanning efforts leads to a diminishing marginal utility. But from a practitioner's point of view, this question must be answered in a far less analytic way, which ultimately necessitates the deliberate neglect of certain aspects in order to avoid information overload.¹⁶

The paper at hand therefore employs systems theory to integrate various perspectives on search strategies for discontinuous innovation into a concise conceptual framework. Systems theory is used because it is capable of slicing the scanning area into multiple levels of analysis while simultaneously maintaining an integrative perspective on the system variables and their interaction, which is indispensable when dealing with discontinuities. Other elements of systems theory – such as openness, complexity, and probabilistic and dynamic behavior – further qualify it as an appropriate theoretical foundation for the conceptual framework.¹⁷

Based on systems theory, search strategies for discontinuous innovation shall be systematized into the following three search fields:

- *macro-environment,*
- *micro-environment,*
- *and intra-corporate level.*

Following the proposed framework, existing research findings were reviewed and evaluated. Table 1 shows key references for each identified search strategy within each of the proposed search fields.

¹⁶ C.f. LICHTENTHALER, E. (2002), p. 32; RÜEGG-STÜRM, J. (2002), p. 12.

¹⁷ C.f. RÜEGG-STÜRM, J. (2002), p. 17ff.; SCHLEGELMILCH, G. (1999), p. 19.

MACRO-ENVIRONMENT	
Innovation Networks	BELDERBOS, R./CARREE, M. et al. (2004); BESSANT, J./KAPLINSKY, R. et al. (2003); BRUCE, M./LEVERICK, F. et al. (1995); BULLINGER, H.-J./AUERNHAMMER, K. et al. (2004); CHESBROUGH, H. W. (2003); DAY, G. S./SCHOEMAKER, P. J. (2004); DHANARAJ, C./PARKHE, A. (2006); DU-SCHEK, S. (2002); HUSTON, L./SAKKAB, N. (2006); HUXHAM, C./HIBBERT, P. (2004); LAURSEN, K./SALTER, A. (2006); LICHTENTHALER, E. (2002); MIOTTI, F./SACHWALD, F. (2003); SCHLEGELMILCH, G. (1999); SOH, P.-H./ROBERTS, E. B. (2003); SPENCER, J. (2003); TIDD, J./BESSANT, J. et al. (2005).
Scenario Analysis	BULLINGER, H.-J./AUERNHAMMER, K. et al. (2004); DAY, G. S./SCHOEMAKER, P. J. (2005); FLEMING, L. (2004); GAUSEMEIER, J. (1995); KRISTEK, U./MÜLLER-STEWENS, G. (1993); KUNZ, P. (2002); LICHTENTHALER, E. (2002); O'CONNOR, G. C. (1998); TRAUFFLER, G./HERSTATT, C. et al. (2004).
Idea-/Trend Scouting	BESSANT, J./BIRKINSHAW, J. et al. (2004b); DAY, G. S./SCHOEMAKER, P. J. (2004); GASSMANN, O./GASO, B. (2004); HOBAN, C. P./ALMQUIST, E. (1999); HUSTON, L./SAKKAB, N. (2006); KRISTEK, U./MÜLLER-STEWENS, G. (1993); LIEBL, F. (1996); LICHTENTHALER, E. (2002); MENON, A./TOMKINS, A. (2004); REICHWALD, R./PILLER, F. (2006); SCIGLIANO, D. (2003); SLYWOTZKY, A. J./QUELLA, J. A. et al. (1999); TIDD, J./BESSANT, J. et al. (2005); VAHS, D./BURMESTER, R. (2002).
MICRO-ENVIRONMENT	
Lead User	ATUAHENE-GIMA, K. (1995); BOWER, J. L./CHRISTENSEN, C. M. (1995); HERSTATT, C. (2001); KLEINALTENKAMP, M. (1996); KIRCHGEORG, M. (2005); LETTL, C. (2004); LILJEN, G. L./MORRISON, P. D. et al. (2002); LÜTHJE, C./HERSTATT, C. (2004); LYNN, G. S./MORONE, J. G. et al. (1996); MORRISON, P. D./ROBERTS, J. H. et al. (2004); REICHWALD, R./PILLER, F. (2006); SCIGLIANO, D. (2003); TIDD, J./BESSANT, J. et al. (2005); URBAN, G. L./VON HIPPEL (1988); VERYZER, R. W. (1998); VON HIPPEL, E. (1986); VON HIPPEL, E. (1988); VON HIPPEL, E./CHURCHILL, J. et al. (1998); VON HIPPEL, E./KATZ, R. (2002); VON HIPPEL, E./THOMKE, S. H. et al. (1999).
Transitory Alliances	BESSANT, J./BIRKINSHAW, J. et al. (2004b); BESSANT, J./LAMMING, R. et al. (2005); BROWN, S./EISENHARDT, K. M. (1998); DUYSTERS, G./DE MAN, A.-P. (2004); DUYSTERS, G./KOK, G. et al. (1999); GULATI, R. (1998); LICHTENTHALER, E. (2002); MEYER, C./RUGGLES, R. (2002); MUNSHI, N./OKE, A. et al. (2005); ROTHARMEL, F. T./DEEDS, D. L. (2004); ROWLEY, R./BEHRENS, D. et al. (2000); SCIGLIANO, D. (2003).
Corporate Venture Capital	BESSANT, J./BIRKINSHAW, J. et al. (2004a); DEBUS, C. (2002); HERSTATT, C. (2003); KRECEK, M. (2005); LICHTENTHALER, E. (2002); MARKIDES, C./GEROSKI, P. A. (2004); SEELY BROWN, J. (2004); STRINGER, R. (2000); TIDD, J./BESSANT, J. et al. (2005); TRAUFFLER, G./HERSTATT, C. et al. (2004); WEBER, C. (2005).
Market Experiments	BROWN, S./EISENHARDT, K. M. (1998); COURTNEY, H./KIRKLAND, J. et al. (1997); DAY, G. S./SCHOEMAKER, P. J. (2005); FLEMING, L./SORENSEN, O. (2003); HARGADON, A./SUTTON, R. I. (1997); HILL, B. (2005); HUSTON, L./SAKKAB, N. (2006); KURTZ, C. F./SNOWDEN, D. J. (2004); LEIFER, R./McDERMOTT, C. M. et al. (2000); LETTL, C. (2004); LODATO, F. (2005); LYNN, G. S./MORONE, J. G. et al. (1996); PRAHALAD, C. K. (2004); SCHILD, K./HERSTATT, C. et al. (2004); STRINGER, R. (2000); TROTT, P. (2002); URBAN, G. L./WEINBERG, B. D. et al. (1996); WATTS, D. J./HASKER, S. (2006).
Unconventional Market Research	CHRISTENSEN, C. M./JOHNSON, M. W./RIGBY, D. K. (2002); CHRISTENSEN, C. M./RAYNOR, M. E. (2003); DAY, G. S./SCHOEMAKER, P. J. (2005); FOSTER, R. N./KAPLAN, S. (2001); FÜLLER, J./BARTL, M. et al. (2004); GASSMANN, O./GASO, B. (2004); HENKEL, J./SANDER, J. G. (2003); HERSTATT, C. (2001); LASSLOP, I. (2000); LEONARD, D./RAYPORT, J. F. (1997); LETTL, C. (2004); LYNN, G. S./MORONE, J. G. et al. (1996); MENON, A./TOMKINS, A. (2004); O'CONNOR, G. C. (1998); REICHWALD, R./PILLER, F. (2006); TIDD, J./BESSANT, J. et al. (2005); WRIGGERS, S. (2004); LUECKE, R. (2003); ZALTMAN, G./COULTER, R. (1995).
INTRA-COMPANY	
Idea Hunter	ANCONA, D./BRESMAN, H. et al. (2002); BESSANT, J./BIRKINSHAW, J. et al. (2004b); BIRKINSHAW, J./FRY, N. (1998); DEBUS, C. (2002); HAUSCHILDT, J./CHAKRABARTI, A. K. (1998); KURTZ, C. F./SNOWDEN, D. J. (2004); LEIFER, R./McDERMOTT, C. M. et al. (2000); LEIFER, R./O'CONNOR, G. C. et al. (2001); LICHTENTHALER, E. (2002); O'CONNOR, G. C./RICE, M. P. (2001); RICE, M. P./KELLEY, D. et al. (2001); ROSENKOPF, L./NERKAR, A. (2001); WITTE, E. (1998).
R&D Information Systems	BESSANT, J. (2003); BRENNAN, A./DOOLEY, L. (2005); LUECKE, R. (2003); MENSEL, N. (2004); WINTER, S. G. (2004).
Company-wide Idea management System	BESSANT, J./BIRKINSHAW, J. et al. (2004a); BIRKINSHAW, J. (2005); CAMPBELL, A./BIRKINSHAW, J. et al. (2003); FOSTER, R. N./KAPLAN, S. (2001); HERSTATT, C. (2003); LEIFER, R./McDERMOTT, C. M. et al. (2000); MENSEL, N. (2004); O'CONNOR, G. C./RICE, M. P. (2001); PHILLIPS, W./NOKE, H. et al. (2004); VAHS, D./BURMESTER, R. (2002).
Venture Teams	CHRISTENSEN, C. M. (2001); CHRISTENSEN, C. M./OVERDORF, M. (2000); CLARK, K. B./WHEELWRIGHT, S. C. (2004); FOSTER, R. N./KAPLAN, S. (2001); GESCHKA, H. (2002); HERSTATT, C. (2003); HUSTON, L. (2004); KRIEGER, A. (2005); LEIFER, R./McDERMOTT, C. M. et al. (2000); LUECKE, R. (2003); MENSEL, N. (2004); MUNSHI, N./OKE, A. et al. (2005); STRINGER, R. (2000); VAHS, D./BURMESTER, R. (2002).

Table 1: Search Strategies for Discontinuous Innovation – Key References

Searching in the Macro-Environment

Search strategies in the *macro-environment* are aimed at the central contexts of entrepreneurial activity.¹⁸ It is an important search field because decisions in this environment have a direct impact on the economic system and the companies operating therein. Relevant objects in the macro-environment include universities, political parties, interest groups, and NGOs. In order to scan this field for weak signals, *innovation networks*, *scenario analysis*, or *idea-/trend scouting* can be applied as search strategies.

- The rationale of *innovation networks* is returns on specialization, as one's own periphery can be another actor's area of focus.¹⁹ Joint learning (e.g. in the form of collaborative research) facilitates the challenge of conventional wisdom, critical reflection of distinct perspectives, and the recognition of patterns of change; its practice thereby yields a competitive edge in the search for discontinuous innovations.²⁰ Examples of frequently used venues of innovation networks are general university cooperations (e.g. university days, organization of scientific seminars, membership in research or industry committees), expert panels, and formal research collaborations.
- A *scenario analysis* develops visions of the future irrespective of the current market environment and situation of the enterprise.²¹ This is done by means of an explorative, top-down approach that allows for multiple futures, connected thinking, and the integration of manifold contingencies. The results are used as a framework to

¹⁸ C.f. RÜEGG-STÜRM, J. (2002), p. 23.

¹⁹ C.f. DAY, G. P./SCHOEMAKER, P. J. (2004), p. 133; SOH, P.-H./ROBERTS, E. B. (2003), p. 1571f.

²⁰ C.f. BESSANT, J./KAPLINSKY, R. et al. (2003), p. 22.

²¹ C.f. KRYSTEK, U./MÜLLER-STEWENS, G. (1993), p. 169.

derive future customer needs and to possibly stimulate the organization to absorb and process weak signals.²²

- *Idea-/trend scouting* is a bottom-up approach to the systematic prediction of future developments based on aggregated weak signals. Interdependent or similar trends are evaluated and consolidated to develop trend landscapes, which can be a source of a discontinuous development.²³ Possible means of identifying such trends include explorative idea searching (e.g. press research, attending fairs and seminars, interviews with trend-setters and futurists), indicator-based models, or pattern thinking.

Searching in the Micro-Environment

This search field contains strategies that scan actors in the market environment. This includes relations to (potential) customers and suppliers of an organization as well as to competitors, complementors, and substitutes. Relevant search strategies in the micro-environment employ *lead users, transitory alliances, corporate venture capital, market experiments, and unconventional market research.*

- *Lead users* face new customer needs with mass-market relevance before the bulk of that marketplace encounters them.²⁴ Additionally, they are expected to benefit significantly from satisfying those needs.²⁵ In the context of discontinuous innovation, collaboration with two types of lead users is especially relevant. The first group are analog users from distinct (but in certain aspects similar) markets offering transferable (technological) solutions. The other group consists of extreme users

²² C.f. DAY, G. P./SCHOEMAKER, P. J. (2005), p. 145f. IBM e.g. uses scenario analysis to derive learning plans (in contrast to business plans) to gradually develop the necessary technical knowledge base. C.f. TRAUFFLER, G./HERSTATT, C. et al. (2004), p. 23.

²³ C.f. KRYSSTEK, U./MÜLLER-STEWENS, G. (1993), p. 196.

²⁴ C.f. VON HIPPEL, E. (1988), p. 107.

²⁵ C.f. *ibid.*

within the relevant market, who require, for example, the highest product quality or extensive functionalities due to situational factors (e.g. climate).

- *Transitory alliances* are temporary cooperations between companies focusing on a specific set of problems to be investigated in a short period of time.²⁶ This configuration allows for broad knowledge acquisition, as multiple options can be scanned on a low solution mode (“radar function”) due to limited relationship investments.²⁷ Partners in transitory alliances can include companies with specific competences, third-party distributors of knowledge (“search parties”), or even competitors.
- *Corporate venture capital (CVC)* is a form of equity financing that is provided by incumbents to support mostly young, fast-growing, and innovative start-up companies.²⁸ The generation of ideas is delegated to the start-ups possessing the relevant competencies, flexibility, and independent structures.²⁹ The incumbent organization only assumes a business development function. For early technology phases (“window on technology”), CVC can clearly be an especially useful instrument.³⁰
- *Market experiments* gradually reduce technological and market uncertainties via an iterative “probe and learn” process.³¹ This is done by introducing prototypes early in the innovation process and evaluating their adoption and diffusion behavior. Relevant methods include multiple (parallel) experiments (“shotgun sampling”) or virtual-reality simulations (“information acceleration”). Using analogies from other industries (e.g. the TRIZ database) or from nature (“bionics”) can also serve as a valuable tool

²⁶ C.f. DUYSTERS, G./DE MAN, A.-P. (2004), p. 52.

²⁷ C.f. DUYSTERS, G./KOK, G. et al. (1999), p. 348; SCIGLIANO, D. (2003), p. 182.

²⁸ C.f. DEBUS, C. (2002), p. 157f.; HERSTATT, C. (2003), p. 266.

²⁹ C.f. MARKIDES, C./GEROSKI, P. A. (2004), p. 29.

³⁰ C.f. DEBUS, C. (2002), p. 160; LICHTENTHALER, E. (2002), p. 271.

³¹ C.f. LYNN, G. P./MORONE, J. G. et al. (1996), p. 19.

for identifying future customer needs or testing the implications of a particular technology.³²

- *Unconventional market research* contains approaches that allow latent customer needs to be identified by challenging present patterns of perception. Qualitative and inductive research methods in particular have proven to be successful in this context.³³ Examples of unconventional market research are innovative segmentation techniques (e.g. “circumstance-based segmentation”); associative, metaphor-based market research (e.g. semiotics, means-end theory); direct observation of customers (“empathic design”); analysis of non-consumers; data mining; and (online-) idea competitions.

Searching Inside the Company

The third search field aims at identifying the potential for discontinuous innovation within the boundaries of the organization. It comprises all entities, activities, and objects that are a legal part of the company, including joint ventures and (foreign) subsidiaries. Relevant search strategies in this context are enlisting *internal idea hunters*, implementing an *R&D information system* or *company-wide idea management system*, or installing *venture teams*.

- *Internal idea hunters* are used to pick up ideas and weak signals within the organization at an early stage.³⁴ Idea hunters are mostly known for their broad technological understanding, business development know-how vis-à-vis assessing market prospects, and their access to key decision-makers.³⁵ They take on the role of a process promoter, who connects the idea generator with functional specialists and the

³² C.f. LEIFER, R./McDERMOTT, C. M. et al. (2000), p. 88; TROTT, P. (2002), p. 238.

³³ C.f. HERSTATT, C. (2001), p. 16ff.; TU BERLIN/McKINSEY et al. (2001), p. 24.

³⁴ C.f. e.g. LEIFER, R./O’CONNOR, G. C. et al. (2001), p. 106.

³⁵ C.f. LEIFER, R./McDERMOTT, C. M. et al. (2000), p. 37f.

general management based on a deep understanding of the organization (“catalyst-function”).³⁶

- With an *R&D information system*, the idea generator does not depend on being discovered by an idea hunter, because the system offers dual form of support for searching for discontinuous innovation: First, it codifies an organization’s explicit knowledge, e.g. in the form of a knowledge-, idea- and/or patent database. Second, it provides access to an organization’s implicit knowledge, e.g. in the form of an expert database (“organizational yellow pages”).
- A *company-wide idea management system* offers all employees – not only the R&D staff – the possibility to contribute to the innovation activities of the organization.³⁷ Frequently used methods of an idea management system are (passive) company suggestion plans or (active) theme-specific internal idea competitions.³⁸
- The use of *venture teams* is an active and structured way of searching for ideas internally. They are selected, cross-functional teams of technology experts and product managers that jointly develop ideas in a limited period of time (e.g. in workshop sessions or as a temporary task force).³⁹ A characteristic feature of venture teams is their organizational autonomy. Venture teams often receive their own budget to come

³⁶ C.f. HAUSCHILDT, J./CHAKRABARTI, A. K. (1998), p. 78. Thus, the relevance of idea hunters can also be explained by the promoter model of innovation, which states that division of labor, i.e. the involvement of distinct people with complementary powers, is necessary to successfully implement innovations against political and knowledge barriers. C.f. WITTE, E. (1998), p. 12ff.

³⁷ C.f. e.g. BESSANT, J./BIRKINSHAW, J. et al. (2004a), p. 34f.; MENSEL, N. (2004), p. 16; PHILLIPS, W./NOKE, H. et al. (2004), p. 14.

³⁸ C.f. BESSANT, J./BIRKINSHAW, J. et al. (2004a), p. 34f.; CAMPBELL, A./BIRKINSHAW, J. et al. (2003), p. 32; HERSTATT, C. (2003), p. 265; LEIFER, R./McDERMOTT, C. M. et al. (2000), p. 26 und p. 33f.; O’CONNOR, G. C./RICE, M. p. (2001), p. 109f.; VAHS, D./BURMESTER, R. (2002), p. 176ff.

³⁹ C.f. e.g. HERSTATT, C. (2003), p. 263f.; HUSTON, L. (2004), p. 193; KRIEGER, A. (2005), p. 89. Focused project groups are also termed „idea sandbox“, „skunkworks“, „idea markets“ oder „heavyweight teams“ in the literature. C.f. for this CLARK, K. B./WHEELWRIGHT, p. C. (2004), p. 420ff.; LEIFER, R./McDERMOTT, C. M. et al. (2000), p. 29f.; LUECKE, R. (2003), p. 36; STRINGER, R. (2000), p. 78.

up with ideas and tend to be decoupled from their line organization, coordinating projects or even working in a separate staff division (e.g. close to the board level).⁴⁰

Integrating the Three Dimensions of Searching for Discontinuous Innovation

Integrating the conceptual framework and the results of the literature review results in a synopsis of search strategies for discontinuous innovation based on systems theory (see Fig. 1). This systematic overview of the current state of knowledge shows that management research provides a set of strategies to identify and process weak signals for discontinuous innovation.

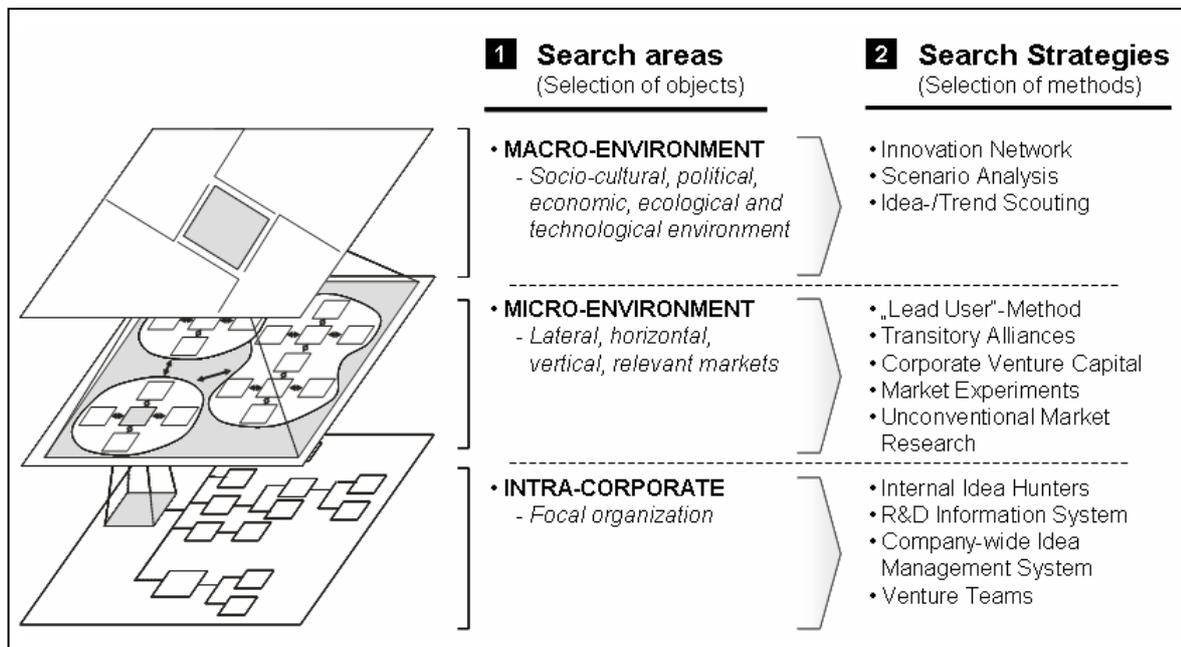


Fig. 1: Overview of Search Strategies for Discontinuous Innovations

One key feature of this framework is its sequential approach to selecting objects and methods. This reduces complexity and shows appropriate strategies depending on the area an organization wishes to scan. But this framework does not show whether the identified strategies are perceived as important from the perspective of board members and innovation

⁴⁰ C.f. CHRISTENSEN, C. M. (2001), p. 34; KRIEGER, A. (2005), p. 89; STRINGER, R. (2000), p. 78. C.f. HERSTATT, C. (2003), p. 263; TU BERLIN/McKINSEY et al. (2001), p. 31.

managers, or whether these strategies are used at all. Thus, in the following section, the relevance and utilization of this theoretical construct shall be mirrored from the field by a broad empirical study.

Finally, the question of whether a relationship exists between relevance and utilization – and if one does, its direction – must be addressed. It is reasonable to expect that search strategies will have varying degrees of relevance and will be unequally used among respondents. Therefore, we anticipate utilization patterns of enterprise clusters that clearly use strategies differently for discontinuous innovation but are consistent among their peers. We therefore anticipate search strategy utilization patterns to vary among clusters but to be uniform within discrete clusters.

RESEARCH DESIGN

Data Collection

The empirical basis for verifying the relevance and utilization of the search strategies was a questionnaire issued to enterprises in Germany. Our research question and the broadly based subject of the questionnaire required a holistic approach to the analysis of search strategies for discontinuous innovation. Hence, the data collection included R&D-intensive businesses of all sizes from four different industries (industrial goods, consumer goods, health care, and information technology). Furthermore, study participants consisted exclusively of senior managers familiar with the topic of innovation and responsible for their enterprises' innovation strategies. Stemming from a dedicated database, 420 board members and innovation managers were invited to take part in our study from July until August 2006, which resulted in n=92 full data sets and a corresponding return rate of 21.9%.

Methods

The methods employed encompass descriptive statistics and cluster analysis. In this study, the utilization rates of search strategies were used as cluster variables to explore the different search patterns of the participating enterprises.⁴¹ As a first step, the Pearson correlation as well as Kendall's tau correlation was calculated to verify the quality of each cluster variable.⁴² The actual clustering was conducted in a three-step approach. First, outliers were identified and isolated using the single linkage method. Next, structure and composition of cluster solutions were explored using the Ward method. The highest decrease of variance ("elbow-criteria") was applied to determine the optimal number of clusters.⁴³ Third, along with the k-means method, a partitioning algorithm was ultimately used to optimize the quality of the cluster solution.⁴⁴

The authors used the calculation of F-values and the examination of dendrograms as performance indices to evaluate the cluster solutions.⁴⁵ Since the cluster solutions compare more than two independent samples, an analysis of variance (ANOVA) was used to test the interpretability of the results.⁴⁶ The homogeneity of variance was investigated via the Levene test. In the case of a significant result from the ANOVA procedure, the Duncan test identified the cluster differing significantly from the others.⁴⁷

⁴¹ C.f. about the objectives of the cluster method in BACHER, J. (1994), p. 1ff.

⁴² BACKHAUS et al. point out that very high correlations can overemphasize specific aspects. C.f. BACKHAUS, K./ERICHSON, B. et al. (2003), p. 537f. For variables scaled in intervals, we used correlations according to PEARSON. The correlation analysis conducted according to KENDALL'S TAU guaranteed calculations for non-normally distributed variables. Both correlations are mentioned in the range [-1,1]. C.f. BÜHL, A./ZÖFEL, P. (2005), p. 322ff.

⁴³ C.f. BACKHAUS, K./ERICHSON, B. et al. (2003), p. 522ff.

⁴⁴ C.f. ECKEY, H.-F./KOSFELD, R. et al. (2002), p. 255ff.

⁴⁵ C.f. BACKHAUS, K./ERICHSON, B. et al. (2003), p. 533ff.

⁴⁶ C.f. BROSIUS, F. (2004), p. 466. A normal distribution is ANOVA's precondition. In principle, the literature assumes that one can calculate with samples of $n \geq 30$ to having a normal distribution. C.f. BORTZ, J./DÖRING, N. (2003), p. 217.

⁴⁷ C.f. BÜHL, A./ZÖFEL, P. (2005), p. 284f.

RESULTS

Relevance and Utilization of Search Strategies for Discontinuous Innovation

The descriptive results of the relevance and utilization of search strategies for discontinuous innovation and are illustrated in Fig. 2. At first glance, the similar run of both distributions is striking. The authors interpret this as a positive sign that businesses would rather practice important search strategies on a systematic level than waste resources on unimportant strategies. Another noteworthy aspect is that the relevance scores show generally higher results than the scores measuring the utilization of search strategies. Hence, enterprises are not practicing search strategies at the targeted relevance level, which suggests the potential for future improvement.

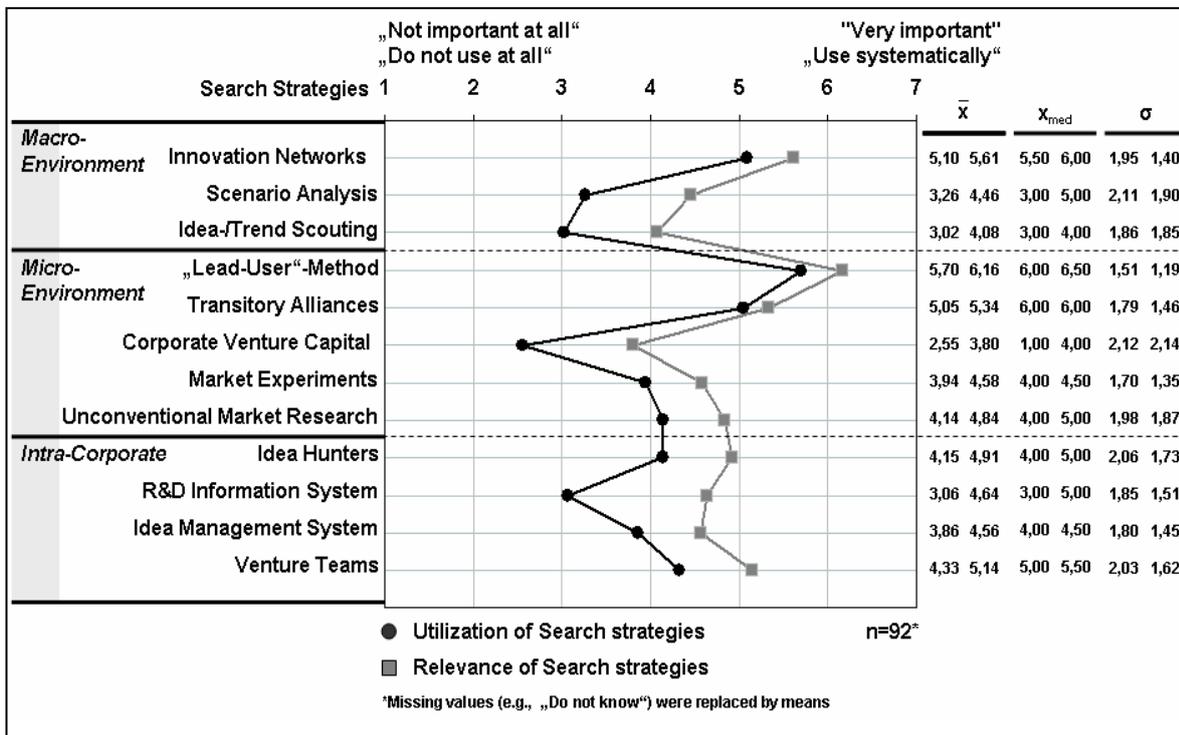


Fig. 2: Relevance and Utilization of Search Strategies

Taking the total sample into account, the most relevant as well as the most practiced search strategies are the *lead user method*, *innovation networks*, and *transitory alliances*. Thus, a major finding is that strategies focusing on cooperative searching for discontinuous innovation have a higher relevance as well as degree of utilization compared to stand-alone strategies. The characteristics of cooperative arrangements, such as a wide scanning area and access to specific implicit knowledge, tend to be highly important in searches for discontinuous innovation. Furthermore, strategies with the highest scores focus on searching in the external (macro- and micro-) environment. In line with scholarly research, these results show that practitioners also seem to view the external environment as the most important search field and the main trigger of discontinuities.

In contrast, the *corporate venture capital* and *idea-/trend scouting* strategies exhibit the lowest arithmetic mean vis-à-vis relevance and utilization. The low score of *corporate venture capital* could stem from its resource intensity as well as its need for a substantial organizational commitment. Surprisingly, the *idea-/trend scouting* score is significantly low. Similar strategies that are likewise characterized by wide, undirected scanning only play a subordinate role in searching for discontinuous innovation (e.g. *scenario analysis*, *market experiments*, and *idea hunters*). The search strategies that tend to be favored are those that focus on specific partners or selective topics (e.g. *lead user method*, *innovation networks*, or *venture teams* in an intra-corporate context). This contradicts the prominent publications that attached great importance to unfocused searches for ideas and trends for weak signals.⁴⁸ Further analysis is needed to clarify this discrepancy, but it could signal that enterprises favor strategies that have a closer connection to their specific market environment and thus offer greater financial accountability.

⁴⁸ C.f. e.g. DAY, G. S./SCHOEMAKER, P. J. (2005), p. 138ff.; TIDD, J./BESSANT, J. et al. (2005), p. 407.

Within the intra-corporate level, active search strategies dominate in importance. Installing *venture teams* appears to be the most important search strategy in this context. Apparently, practitioners are not confident that passive search strategies like *R&D information systems* and *idea management systems* are capable of spurring discontinuous innovations.

Patterns of Utilization of Search Strategies for Discontinuous Innovation

So far, the results of the empirical study have described the arithmetic means based on the total sample. In order to identify different patterns of utilization, it is necessary to apply cluster analysis. Using the three-step approach outlined, three clusters of $n_1=49$ (54.4%), $n_2=21$ (23.3%), and $n_3=20$ (22.2%) companies were found.⁴⁹

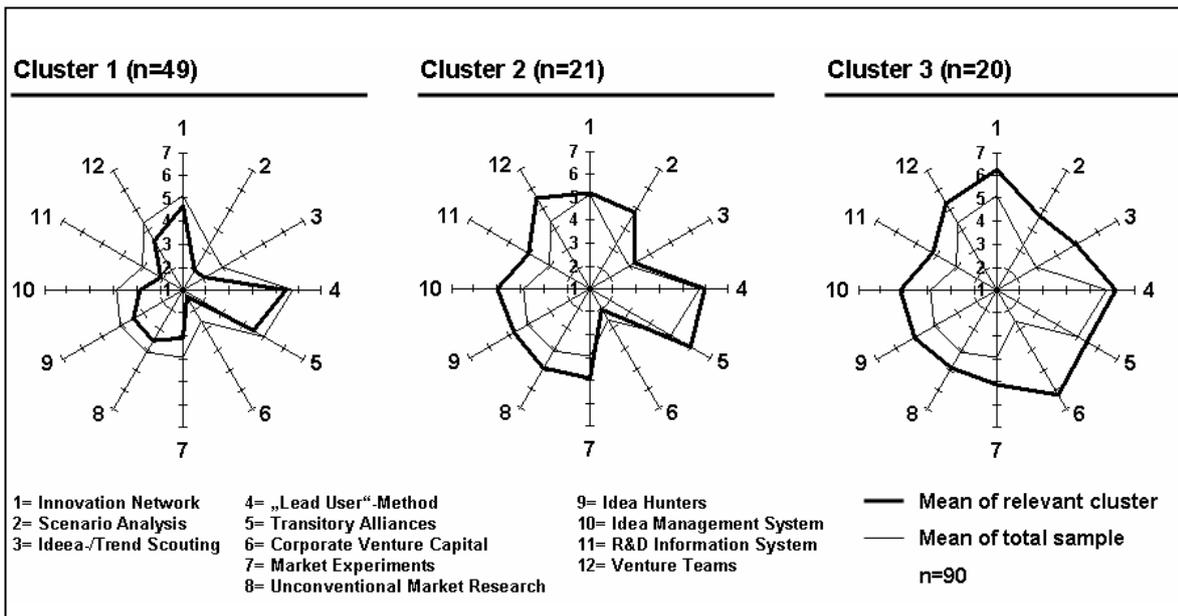


Abb. 3: Arithmetic Means of the Clusters

⁴⁹ Evaluation of F-values, dendrograms, and elbow criteria suggested a three-cluster solution.

The ANOVA showed that the clusters differed significantly with respect to all variables, excluding the *lead user method*.⁵⁰ The subsequent Duncan test compared the arithmetic means and indicated significant results on each level of the subgroups. Fig. 3 illustrates the arithmetic mean of each cluster and its deviation from the mean of the total sample.

Based on these results, the clusters can be described as follows:

- *Cluster 1:* Businesses in the first cluster make only limited use of search strategies. The degree of utilization of this cluster is 23% below the total sample. Additionally, this cluster differs significantly in a multitude of variables compared to clusters 2 and 3, which is shown by the results of the Duncan test. Enterprises in the first cluster do not search for discontinuous innovations in a systematic way; only a few, selective strategies are applied.
- *Cluster 2:* The second group practices search strategies to a considerably greater degree in comparison to the total sample. The degree of utilization of search strategies exceeds the arithmetic mean of the total sample by 17%. Interestingly, this cluster makes very heavy use of specific search strategies and completely leaves out others. This cluster is therefore characterized by a focused and systematic approach that employs specific strategies to search for discontinuous innovation.
- *Cluster 3:* Enterprises in the third cluster show the highest degree of utilization, topping the mean of the total sample by 38%. This cluster typically excels not only with respect to overall activity level but also in terms of breadth of strategies employed.

⁵⁰ The lead user search strategy is significant at the level of $p=0.18$. As this strategy is the most frequently used among all businesses, the differences in arithmetic means decrease.

The description of the clusters reveals the heterogeneous characteristics in the utilization of search strategies. The three groups can be distinguished by two dimensions that take the descriptive variations of the variables into account.

First, businesses can be differentiated by degree of implementation, i.e. whether they practice search strategies in a more or less consistent and systematic way. A relevant indicator is the arithmetic mean of the utilization of each search strategy and its deviation from the score of the total sample. In particular, the results of the Duncan test indicate that cluster 1 deviates significantly from clusters 2 and 3 in this respect. The latter clusters tend to be more homogeneous along this dimension, as their degrees of implementation are both way above average.

The second dimension depicts the breadth of search strategies practiced. Indicators for this dimension are the number of search strategies used concurrently by the enterprises. The comparison of the three clusters shows that those exhibiting a high degree of implementation differ in terms of the breadth of search strategies applied. Again, the Duncan test confirms significant differences between clusters 2 and 3 in this respect. This result is further supported by the comparison of the two- and the three-cluster solutions (see Appendix 4). It illustrates that enterprises assigned to the cluster 2 in a two-cluster solution subdivide into clusters 2 and 3 in a three-cluster solution.

DISCUSSION

This paper's focus was search strategies for discontinuous innovation. Its aim was to deliver an integrative contribution by systematizing the research field and acquiring empirical knowledge about the relevance and the utilization of the respective search strategies.

Our conceptual framework reviews recent theory building in the field of search strategies for discontinuous innovation and provides orientation for further theoretical discussions. The identification as well as the systematization of the twelve search strategies yields evidence that despite a great degree of uncertainty and imponderability, enterprises have instruments with which to systematically search for discontinuous innovation. Identifying discontinuous innovations therefore does not have to depend upon an unpredictable, serendipitous coincidence.⁵¹

Furthermore, our strong empirical support for cooperative search strategies is in line with recent scholarly publications whose innovation model is open for complementary partners (“Open Innovation”).⁵² In this context, our research highlights the relevance of cooperation at the earliest stages of the innovation process – quite apart from its later phases.

The identification of specific utilization patterns of search strategies for discontinuous innovations is a further important contribution. Our typology of businesses showed that utilization patterns of search strategies do not simply follow a dichotomous classification into good and bad searchers. Our empirical results suggest that organizations that systematically engage in searching for discontinuous innovation ought to be differentiated according to the breadth of strategies employed into focused and diversified searchers. The typology of this paper enhances the understanding of how to search for discontinuous innovation as well as how strategic patterns are formed in businesses, and could encourage further research in this field.

⁵¹ C.f. e.g. GARCIA, R./CALANTONE, R. (2002), p. 127.

⁵² C.f. e.g. CHESBROUGH, H. W. (2003), p. 36f.; LAURSEN, K./SALTER, A. (2006), p. 145f.

OUTLOOK

For the purpose of consistent and steady research progress, we propose that further research on searching for discontinuous innovation be conducted based on the results of the paper at hand. Our systematization of search strategies offers a preliminary framework that could be refined and differentiated by further contributions. In focusing on systematizing and empirically analyzing search strategies, this paper gives no detailed description of the different search strategies and respective implementation options. Therefore, future research could focus on detailing specific search strategies and evaluating their individual contributions to the discovery of discontinuous innovations.

Additionally, theory building could also pursue the path of the quantitative study. The current analysis is limited to four industries (industrial goods, consumer goods, health care, and information technology) with a geographical focus on Germany. Therefore, the explanatory power of its results is restricted. Furthermore, a second study employing performance metrics, such as the quantity and quality of ideas generated by each search strategy, would be especially interesting. The study at hand presents an indirect indication of relative performance vis-à-vis importance and utilization, but is not capable of delivering direct results concerning the relation between search strategies, patterns of utilizations, and performance.

In an environment with continuous structural interruptions, which authors such as Drucker call the “Age of Discontinuity”, discontinuous innovation remains a thriving area of research.⁵³ Despite all the challenges and uncertainties in the field of discontinuous innovation, researchers should nonetheless seize this great opportunity to advance the current state of knowledge.

⁵³ C.f. DRUCKER, P. F. (1969).

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APPENDIX 1: CORRELATION ANALYSIS OF CLUSTER VARIABLES

Values above the main diagonal represent Kendall tau correlations; underneath are the Pearson correlations. A two-sided significance test was applied.

Utilization of Search Strategies	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Idea Hunters (1)	1	0,268**	0,175*	0,368**	-0,064	0,126	0,239**	0,117	0,098	0,007	0,212**	0,137
Company-wide Idea Management System (2)	0,346**	1	0,330**	0,392**	0,051	0,136	0,424**	0,345**	0,268**	0,074	0,447**	0,252**
R&D Information System (3)	0,228*	0,443**	1	0,258**	0,092	0,146	0,331**	0,251**	0,202*	0,290**	0,345**	0,273**
Venture Team (4)	0,476**	0,523**	0,373**	1	-0,018	0,086	0,194*	0,137	0,105	0,063	0,347**	0,158
„Lead User“-method (5)	-0,072	0,078	0,145	-0,033	1	0,311**	0,065	0,226**	0,262**	0,312**	0,050	0,161
Transitory Alliances (6)	0,128	0,176	0,138	0,072	0,373**	1	0,164	0,178*	0,200*	0,113	0,012	0,102
Corporate Venture Capital (7)	0,226*	0,474**	0,381**	0,265*	0,125	0,185	1	0,403**	0,183*	0,139	0,414**	0,456**
Market Experiments (8)	0,150	0,466**	0,335**	0,163	0,310**	0,232*	0,442**	1	0,360**	0,100	0,359**	0,274**
Unconventional Market Research(9)	0,127	0,367**	0,216*	0,140	0,265**	0,251*	0,233*	0,455**	1	-0,007	0,108	0,270**
Innovation Networks (10)	-0,040	0,078	0,329**	0,024	0,405**	0,134	0,223*	0,150	0,001	1	0,150	0,186*
Scenario Analysis (11)	0,268**	0,558**	0,454**	0,436**	0,166	0,003	0,420**	0,442**	0,130	0,184	1	0,348**
Idea-Trend Scouting (12)	0,214*	0,306**	0,345**	0,176	0,191	0,089	0,561**	0,286**	0,303**	0,227*	0,361*	1

APPENDIX 2: COMPARISON OF ARITHMETIC MEANS OF CLUSTERS AND ITS DEVIATION FROM ARITHMETIC MEAN OF TOTAL SAMPLE

Utilization of Search Strategies	Total sample (n=90)		Cluster 1 (n=49)		Cluster 2 (n=21)		Cluster 3 (n=20)	
	ρ	\bar{x}	\bar{x}	Δ	\bar{x}	Δ	\bar{x}	Δ
Innovation Networks	0.009 (**)	5.110	4.647	-9.1	5.152	+0.8	6.200**	+21.3
Scenario Analysis	0.000 (***)	3.244	1.980***	-39.0	4.810	+48.2	4.700	+44.9
Idea-/Trend Scouting	0.000 (***)	2.946	2.042**	-30.7	3.195**	+8.4	4.901***	+66.4
„Lead User“-Method	0.180	5.691	5.422	-4.7	5.942	+4.4	6.085	+6.9
Transitory Alliances	0.001 (***)	5.060	4.473***	-11.6	6.007	+18.7	5.502	+8.7
Corporate Venture Capital	0.000 (***)	2.575	1.329**	-48.4	2.031**	-21.1	6:200**	+140.8
Market Experiments	0.000 (***)	3.941	3.076***	-21.9	4.878	+23.8	5.075	+28.8
Unconventional Market Research	0.003 (**)	4.152	3.513**	-15.4	4.972	+19.7	4.857	+17.0
Internal Idea Hunters	0.002 (**)	4.149	3.493**	-15.8	4.776	+15.1	5.100	+22.9
Corporate-wide Idea Management System	0.000 (***)	3.854	2.859***	-25.8	4.966	+28.9	5.125	+33.0
R&D Information System	0.000 (***)	3.006	2.102***	-30.1	4.003	+33.2	4.173	+38.8
Venture Team	0.000 (***)	4.348	3.449***	-20.7	5.540	+27.4	5.300	+21.9

APPENDIX 3: F-VALUES OF TWO- AND THREE-CLUSTER SOLUTIONS USING THE WARD AND K-MEANS METHODS

	WARD-method						K-MEANS-method					
	2 cluster solution		3 cluster solution			2 cluster solution			3 cluster solution			
	Cluster 1	Cluster 2	Cluster 1	Cluster 2	Cluster 3	Cluster 1	Cluster 2	Cluster 3	Cluster 1	Cluster 2	Cluster 3	
Idea Hunters	0,7150	1,0843	1,0843	0,5780	0,7488	0,9543	0,8185	0,9619	0,5747	1,0439		
Company-wide Idea Management System	0,3477	0,5546	0,5546	0,3309	0,3540	0,6359	0,4737	0,6400	0,5565	0,7463		
R&D Information System	1,0386	0,4929	0,4929	1,0213	1,0398	0,4650	1,0467	0,4615	1,0462	1,0283		
Venture Team	0,5000	1,1097	1,1097	0,5573	0,3758	1,0160	0,4704	1,0245	0,2990	0,6492		
„Lead User“-method	0,5407	1,3652	1,3652	0,3501	0,8405	1,1104	0,8125	1,1321	0,8275	0,7721		
Transitory Alliances	0,5166	1,2892	1,2892	0,2423	0,9062	1,1429	0,5432	1,1471	0,2510	0,8564		
Corporate Venture Capital	1,0991	0,3255	0,3255	0,2535	0,1609	0,1010	1,1677	0,1027	0,2833	0,1520		
Market Experiments	0,5041	0,9636	0,9636	0,5708	0,4316	0,8145	0,5259	0,8277	0,5899	0,4464		
Unconventional Market Research	0,6083	1,1034	1,1034	0,5509	0,7160	1,0737	0,5801	1,1049	0,5995	0,6600		
Innovation Networks	0,9772	1,0193	1,0193	1,2165	0,3088	1,0708	0,8004	1,0871	1,0911	0,3057		
Scenario Analysis	0,7967	0,4925	0,4925	0,7659	0,8409	0,5354	0,6633	0,4772	0,5003	0,8549		
Idea-/Trend Scouting	0,9870	0,7002	0,7002	0,5656	0,7236	0,6373	0,8495	0,60	0,5117	0,7091		
∅ of F-Values of each cluster	0,7193	0,8750	0,8750	0,5836	0,6206	0,7964	0,7293	0,7972	0,5942	0,6854		
	0,7971			0,6931		0,7629			0,6923			

APPENDIX 4: COMPARISON OF ARITHMETIC MEANS OF TWO- AND THREE-CLUSTER SOLUTIONS

