Handling Uncertainty in Innovation Management – an empirical analysis of innovative organizations

Patrick Brandtner [a], Andreas Auinger [a], Kurt Gaubinger [b], Michael Rabl [b]

[a] University of Applied Sciences Upper Austria, School of Management, Wehrgrabengasse 1-3, 4400 Steyr, AUSTRIA

[b] University of Applied Sciences Upper Austria, School of Engineering and Environmental Sciences, Stelzhamerstraße 23, 4600 Wels, AUSTRIA

KURZFASSUNG/ABSTRACT:

Innovation Management is marked by a high degree of uncertainty, which represents a major challenge for organizations. In the course of the current research paper, a qualitative study was conducted to gain an overview of the different activities applied and the methods used in order to deal with uncertainty along the particular phases of the innovation process. The main findings of this paper represent a summary of best practices in innovative organizations regarding the application of appropriate tools, methods and techniques to systematically reduce uncertainty. The results indicate that mainly long-proven and established methods like the lead user approach, competition analysis are used, e.g. product roadmaps or portfolios were more rarely mentioned. The paper concludes with a discussion of theoretical and practical implications of our study.

1 INTRODUCTION

Constantly changing market requirements, technological dynamics and the need to develop innovative products or services with a high degree of novelty pose huge challenges to organizations. Especially the early stages of the innovation process – the so called Front End of Innovation – are accompanied by great uncertainties which further increase the intricacy of the innovation process. Those uncertainties have to be identified, monitored and managed along the different stages and activities of the innovation process. There are quite a few methods and approaches which can be applied in order to handle and reduce uncertainty, e.g. innovation portfolios, roadmaps, trend monitoring or different forms of cooperating with internal and external knowledge sources. Such methods offer great potential for organizations and can clearly improve their innovativeness [1]. Numerous research contributions have been proposed concerning the dimensions of uncertainty in innovation management and its effects on the organizational innovation process. Furthermore, there are quite a few prominent and acknowledged methods and techniques for reducing and managing uncertainty in this context.

Unfortunately, many companies do not systematically apply such methods, be it because of inexpertness in applying them in the course of the innovation process or be it because of not having realized their potential value for increasing innovativeness and reducing uncertainty. The current research paper analyzes the use of just such tools, methods and techniques applied in highly innovative Austrian companies, which haven been awarded for their innovatory success. In section two, our understanding of innovation management and of uncertainty in this context is explained based on scientific literature. Section three addresses the research design and the methodological steps applied in this paper. The findings of the conducted benchmarking study are discussed in section four. Subsequently, section five concludes the paper and discusses the contributions and practical implications of the current research.

2 CURRENT UNDERSTANDING

In section 2, the understanding of innovation management, the innovation process relevant for the current paper and our understanding of uncertainty in the context of innovation management are discussed.

2.1 Innovation Management

Innovation Management includes all activities and tasks aiming at successfully introducing an innovation to market or for the company's internal use. The management of innovations comprises a comprehensive set of strategic and operational task necessary in order to plan, organize and control an organisation's innovation process and create the required operational framework. According to Vahs and Brem [13], the core tasks of innovation management include:

- Defining innovation goals and strategies
- Planning, steering and controlling innovation processes
- Building and maintaining an information system serving as the basis for goal-oriented innovation control
- Building an organization structure conducive to innovation
- Building and maintaining an innovation-friendly company culture.

The overall goal of innovation management is to build, maintain and increase the competitive advantage of a company and to ensure its economic success in the long term [9, 14]. Based on this understanding of innovation management the following section deals with the innovation process relevant for the current paper.

2.2 Innovation Management Process Model

Based on Cooper's second-generation innovation process model [10] Gaubinger et al. [9] developed a phase model of integrated innovation and product management (cf. fig. 2). Besides specifically taking into account uncertainty this model emphasizes the cross-functional and interdisciplinary nature of all innovation and product management related activities. Because of its comprehensive approach to innovation management and because of its specific focus on uncertainty reduction, this model was used to serve as a reference framework for the current benchmarking study (cf. section 3):

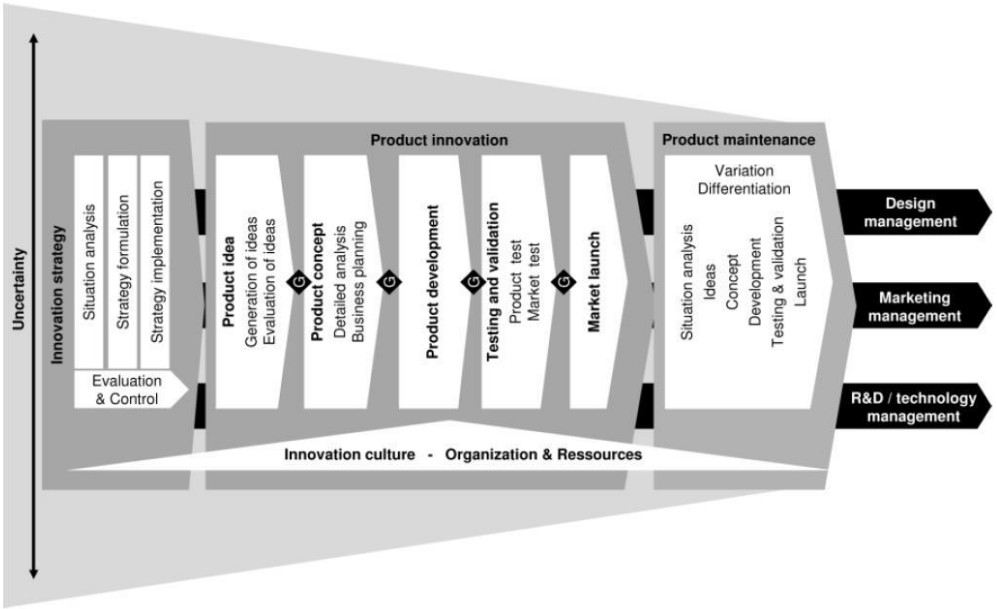

Figure 1. Process Model of integrated Innovation Management (Gaubinger et al. 2015)

Uncertainty has a major influence on innovation management. Long-term market success strongly depends on an organisation's ability to continuously monitor both internal and external developments. Several methods can be applied to identify and evaluate developments and

events in the relevant company environment and to predict their possible evolution, e.g. scenario planning, patent monitoring or market research. By collecting and analyzing relevant information from inside and outside the company (situation analysis, cf. figure 2), uncertainty can be converted to a calculated risk [15] and an appropriate innovation strategy can be formulated in a next step (cf. figure 2). The implemented innovation strategy is meant to provide a framework for all following innovation activities. According to Gaubinger et al. [9] (cf. figure 2) ideas are in a next step generated and evaluated, and the most promising ones are subjected to further detailing and specification in form of a product concept. Relevant and feasible product concepts are subsequently transferred to actual product development. Depending on the complexity and the strategic importance of the developed product innovation, different test have to be conducted (e.g. prototype tests, market tests) in order to decrease uncertainty in connection to the market launch-stage [9].

In the course of a product maintenance phase, products have to be changed or improved regularly if necessary. Every activity along the stages of the innovation process depicted in figure 2 further reduces uncertainty by gaining additional knowledge and increases the chances of a successful product innovation [9]. Innovation culture as well as organizational structure and resources are two important factors providing the framework for the innovation activities taking place in the single stages of the innovation process.

2.3 Uncertainty

Uncertainty has been a frequent issue in organization theory over the past decades. In literature, there is a broad consensus that most organizational decisions are made in uncertainty, mainly because of missing information and knowledge about the company environment or due to a lack of stability and consistency. This is even truer in innovation management, where the need for systematically dealing with uncertainties is particularly high and where corporate foresight represents a key element [2–5].

The dimensions and effects of uncertainty in innovation management have been a frequent issue in scientific literature. Quite a few methods and techniques for reducing and managing uncertainty in this context have been developed. Nonetheless, most companies – especially small and medium sized ones – do not seem to take advantage of such methods and often encounter difficulties in managing uncertainty at the „Fuzzy Front End of Innovation“.

3 RESEARCH OBJECTIVES AND RESEARCH DESIGN

The current research analyzes how leading Austrian innovators are dealing with uncertainty. Based on a thorough selection process, highly innovative, awarded companies were analyzed to identify the Best-In-Practice approaches in terms of activities and use of methods in dealing with uncertainties in innovation management.

For this purpose, external, industry irrespective and anonymous Best Practice benchmarking was chosen as the most equitable approach to assess and compare the selected, highly innovative companies. In accordance with acknowledged benchmarking processes [6-8] the methodology applied to conduct the Best Practice benchmarking was developed:

The benchmarking object and the performance assessment criteria were defined based on an innovation process model laying a specific focus on „Dealing with Uncertainty“ (cf. section 2) in the context of Open Innovation [9]. This process model was developed in accordance with Cooper’s popular NexGen process model [10] and its structure provides the framework for conducting the expert interview in the course of the analysis phase of the current benchmarking procedure.

As empirical studies on this subject are scarce, an explorative research design was chosen for this benchmarking project, to analyze the innovation frameworks of the companies, realized by a qualitative research using a semi-structured questionnaire. The Sample was drawn in two steps: First, companies from Upper Austria with outstanding records in innovation management (innovation awards, prizes, etc.) were selected according to a set of specific criteria. Secondly,

we identified and approached the people in charge of innovation management in the selected companies. This sampling procedure was chosen to keep the number of interviews low and to gather meaningful information [11].

In total, 14 from initially 40 companies (cf. table 1) were interviewed in spring 2013. All interviews were recorded with prior permission and analyzed using the four-step procedure suggested by Lamnek [12].

Table 1. Sample of the benchmarking study

Industry	*Selection criteria*	*Employees*	*Turnover (approx.)*	*Expert*
Agricultural Technology	Innovation Award 2011	1370	275 mil. Euros	Innovation Management
Machine / Plant Engineering	Best Idea Management 2013	570	75 mil. Euros	Product Development
Metal Processing	Innovation Award 2009	230	50 mil. Euros	Product Development
Machine Engineering	Frontrunner 2013	~2000	600 mil. Euros	Idea Management
Machine Engineering	Blechnet Award 2013	~9500	2,3 bn. Euros	Product Management
Electrical Engineering	Frontrunner Company 2013	~3200	500 mil. Euros	Innovation Management
Aviation / Plastics Engineering	Innovation Award 2012	1450	175 mil. Euros	Innovation and Development
Aviation	Innovation Prize 2013	2000	350 mil. Euros	Prototype Development
Motor Engineering	Automotive Innovation Award 2013	150	950 mil. Euros	Innovation Management
Automation	Product Design Award 2010	785	125 mil. Euros	Innovation Management
Electronics	National Innovation Prize 2013	~3000	1,2 bn. Euros	Innovation Management
IT	NetApp Innovation Award 2012	600	n.a.	Innovation Management
Metal Industry	US-A-Biz Award for Innovation 2012	120	25 mil. Euros	Product Development
Metal Industry	Product Innovation Prize 2009	~500	122 mil. Euros	Innovation Management

The results of the benchmarking study are presented in section 4.

4 RESULTS OF THE BENCHMARKING STUDY

The conduction of the benchmarking study following the procedure defined in section 3 allowed us to collect a comprehensive pool of activities and methods applied in order to reduce uncertainty along the phases of the defined process model (cf. section 2). An overview of the meth-

ods used respectively the activities conducted is provided in figure 3, the numbers in brackets indicate the amount of times the respective item was mentioned:

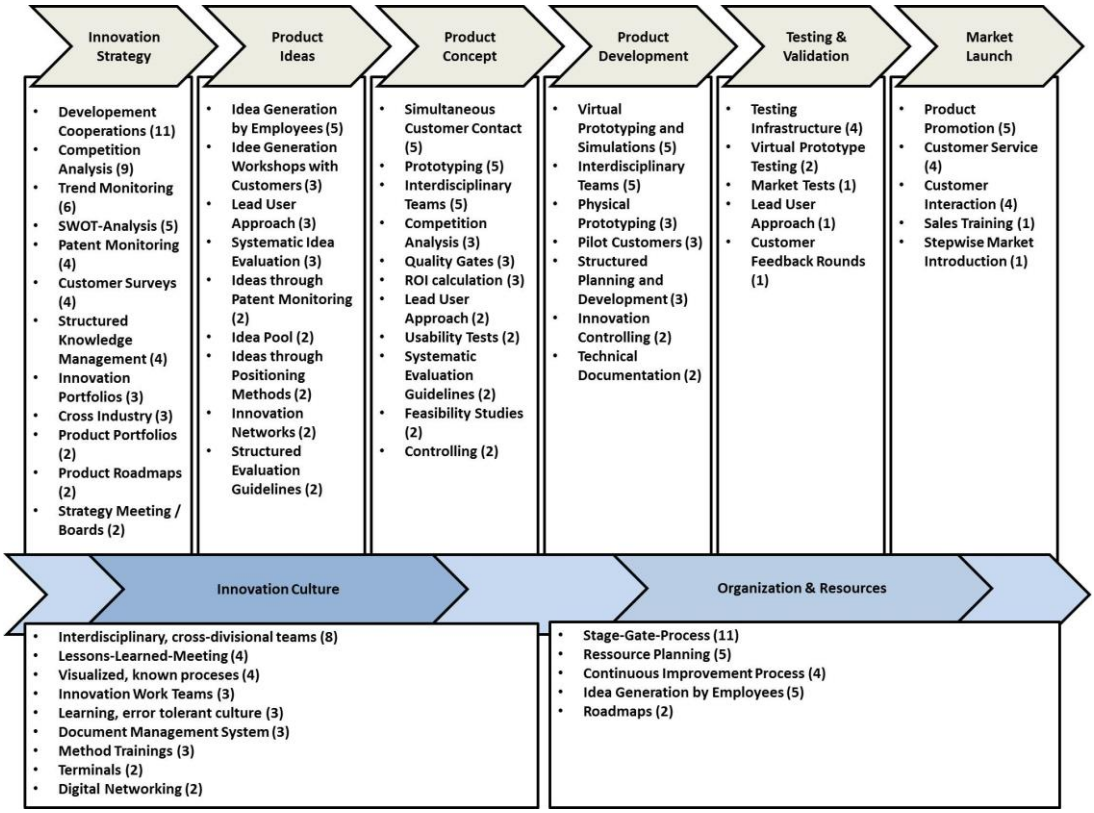

Figure 2. Overview of main activities and methods applied in the different stages of the innovation process in the companies surveyed

The reduction of uncertainty in the course of the **innovation strategy**-phase is mainly done using development cooperations, competition analysis and Trendmonitoring. More rarely mentioned at this stage were e.g. swot analysis, patent monitoring, customer surveys or innovation portfolios and cross industry collaboration. Up to a very limited extent, also product portfolios, product roadmaps and regular strategy meetings were mentioned at this stage of the innovation process. Furthermore, the importance of a structured knowledge management process was mentioned in this initial stage of the innovation process in order to decrease knowledge loss and increase information transfer.

The conducted benchmarking study revealed that there are basically two ways of generating **product ideas**: internal and external idea generation. Internal idea sources (mainly employees) are tapped by applying idea workshops, external sources by using customer workshops or by following the lead-user-approach. Up to a limited extent, software based support for idea generation was provided in the form of idea pools and idea management software. Other methods mentioned to decrease uncertainty and to expand the information available in the course of the product ideation phase are patent monitoring and the application of positioning methods. The use of methods to systematically select product ideas was only observable up to a limited extent and evaluation guidelines were seldom provided by the companies.

In the **product concept**-phase, simultaneous costumer contact, prototyping and interdisciplinary teams were the most mentioned methods. The importance of costumer contact in this

stage of the innovation process was again emphasised by the companies surveyed. Customer requirements must not be neglected during concept definition and a continuous alignment of concept specifications and customer requirements was regarded as important at this stage. Usability tests, systematic evaluation guidelines and the implementation of controlling procedures respectively feasibility studies were also mentioned here. Furthermore, the application of competition analysis, quality gates and ROI calculation could be observed in this stage of the innovation process.

Uncertainty reduction in the **product development** stage is mainly supported by virtual prototyping and simulations and by building on interdisciplinary teams in order to cover the different aspects and point of views necessary in product development. This interdisciplinary nature of teams was considered a critical success factor in this context, especially when FMEA (failure modes and effects analysis) or DRBFM (design review based failure modes) are used. Physical prototyping, the integration of pilot customers or a clearly structured planning and development process were only mentioned up to a limited extent. The documentation of technical, product related information was also mentioned here.

In order to further reduce uncertainty before introducing a product to market, quite a few companies conduct specific product **testing and validation**. In this context, mainly laboratories and testing facilities and again virtual prototyping are applied. As expected, depending on the size and business area of the respective company, the complexity and size of testing facilities varied a lot. Again, customer integration was highlighted as an important source for gaining direct feedback before the actual product launch. In this context, also lead user integration and the conduction of customer feedback rounds were mentioned.

In the final stage of **market launch**, product promotion, customer services and constant customer contact were mentioned most. Hereby, product promotion mainly takes place in the course of trade fairs or technical exhibitions. Additionally, a stepwise market introduction as well specific sales trainings could also be observed in the companies surveyed.

As discussed before, innovation culture as well as organizational structure and resources are two important factors providing the framework for all innovation activities. In order to reduce uncertainty regarding **innovation culture**, interdisciplinary and cross-departmental teams, lessons-learned meetings and common processes were mentioned. Furthermore, innovation work teams, a learning and error-tolerant culture, method training and it-based support in the form of document management systems were applied to improve innovation culture and reduce risks in this context. Regarding **organizational structure and resources**, the implementation of a stage-gate-process, resource planning, idea generation by employees, a continuous improvement processes and the application of roadmaps were mentioned.

5 FINDINGS AND CONTRIBUTION

In the course of the current benchmarking procedure, several Expert Interviews with Innovation Managers from selected companies were conducted. By that, a comprehensive overview of activities, tools and method use in regard to uncertainty reduction in innovation management could be gained. One of the main findings was that although uncertainty mainly occurs implicitly, each of the analyzed companies conducts a wide array of activities and applies a more or less comprehensive set of methods to manage it. Besides the collection of activities and method use quite a few critical success factors and core competencies in regard to uncertainty management along the innovation process could be identified as well: e.g. cross-functional, highly diverse teams, open and transparent communication, the integration of customers, the identification and integration of experts, an innovation-friendly corporate culture or the provision of an incentive system.

The practical implications of the current paper are considerably high: The results represent a comprehensive yet concise summary of activities, methods, tools and techniques applied in Best in Practice organizations in order to deal with uncertainties in innovation management. Furthermore, the current paper provides a basis and reference source for deriving concrete measures for action to improve an organization's capability to handle and manage uncertainty along its innovation process.

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