A comprehensive framework for successful commercialization of technology push innovations

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ABSTRACT:
Innovations evolve in different ways, either triggered by customer needs or pushed by radical technological developments. Particularly for technology push innovations the stage between the prototype and the market entry can be identified as a critical factor of success. Within this phase it is necessary to model, modify and adapt the technology push innovation to the market requirements as well as possible, and on the other hand, to find methods and options to prepare the target market for the launch of a prospective revolutionizing technology. The most difficult task is to find the correct spread being as innovative as possible, as radical as necessary but still staying focused on the potential market needs. In the following paper a comprehensive model for a successful commercialization of technology push innovations is developed, which is supplemented by the DIA model as well as the Stage-Gate Technology Development (TD) process. Supporting the framework, specific characteristics of technology push innovations are defined and summarized within a table of critical success factors, where uncertainty was identified as an important and omnipresent factor.

1 INTRODUCTION

One of the major questions of modern technology oriented enterprises is whether new innovations are initiated through technology push (TP) or market pull approaches [1]. New technologies developed within the R&D facilities of a company are often pushed into a potential target market with hardly any knowledge about market performance or cumulative adopters. Hence, the introduction of such technology push innovations is linked with a significant level of risk and market uncertainty [2]. TP scenarios require a formidable amount of organizational resources, have a higher technological uncertainty and introduce a certain level of risk, whilst offering a huge market potential. This leads to the central research question of this paper: Which strategic process framework is necessary to manage TP innovations until a maturity stage is reached to become a successful market revolutionizing product? Based on the identification of critical success factors (CSF) and supplemented by the analysis and combination of state-of-the-art product development processes, a novel comprehensive TP framework is designed to identify a suitable approach to manipulate TP innovations for a successful market launch.

This paper is structured as follows. Section 2 discusses a broad literature review on TP and innovation management. Section 3 introduces the comprehensive TP framework approach. In section 4 the first implementation and partial verification of individual steps of the TP framework is presented. A final conclusion is drawn in section 5.

2 LITERATURE REVIEW

2.1 Managing Innovation

The development and introduction of new innovative goods will permanently come along with certain risks combined with uncertainty. Given the risk levels introduced by new innovations in combination with high complexity, new technology developments require a profound management of the innovation process [3].

Innovation management identifies how a company handles its developments. Furthermore, the strategic approach towards future goals is analyzed and implemented [4]. Hence, innovation management relies primarily on a process based environment which leads to a conscious shaping of innovation processes. But it is understood that a clear distinction between innovation processes and R&D processes has to be made, because a R&D process can be truly classified as innovation process, but vice-versa an innovation process is not necessarily bound into research or development sequences at all [5].

Many companies already run a technology or R&D management program to push innovations. By having a look at the graph in figure 1, different stages beginning from the first basic research approach through the development stages to the market entry point can be identified. Furthermore, it is shown that the R&D management process, respectively the technology management approach focuses on a very narrow spectrum only [4].

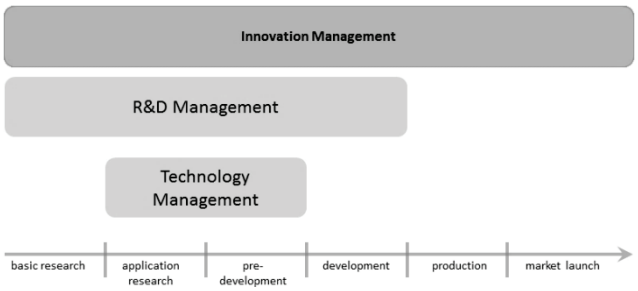

Figure 1: Spectrum of innovation management. (Adapted from [2,4])

The importance of a well-structured TD process and its critical impact on company growth and success is evident. Based on the fact that technology driven innovations will come along with higher risk and uncertainty levels, a new process called Stage-Gate- TD was designed. The key is to introduce an iterative 3 Stage process of project scoping, technical assessment and detailed investigation, and loading these steps with promising ideas, as a pre-step to a company's product development process [6,7].

Hence a holistic Innovation management approach means much more than only focusing on a product development or a research phase, it has to cover the specific stages within a product life-cycle from the invention of a new technology throughout its development until the product is ready for the market launch [4].

2.2 Critical Success Factors for Technology Push Innovation

For developing a comprehensive TP framework it is not only vital to understand this specific type of innovation but also its CSF which are directly influencing the level of risk and acceptance of new technologies. In common literature, various CSF for technology push innovations are discussed to verify the competitive success of an organization [8]. However, according to Stern et al a general approach of defining common characteristic patterns for the clustering of CSF should be manageable. Such basic patterns may be considered as arrays which can be customized and adapted to a company's individual needs [9]. Based on numerous empirical case studies, meta-analysis and correlations Henard and Szymanski consider **product**, **company** and **market related criteria** as common patterns of CSF for introducing new products [10].

In addition to this identification of common success criteria, the influence of uncertainty as an omnipresent factor influencing innovation processes may be considered. Besides the influence of uncertainty, a company's employees innovation ethos is impacting the ability to generate and commercialize innovation. To a certain degree both factors, uncertainty and innovation ethos, are associated with especially low uncertainty levels fostering a positive innovation culture within an organization. Such positive motivation of departments and project teams can be consid-

ered as a basic module for generating sturdy innovation ideas which again are necessary to avoid innovation uncertainty [11].

By combining the above mentioned criteria and patterns, a comparative model of common patterns for identifying CSF, depict in figure 2, can be determined.

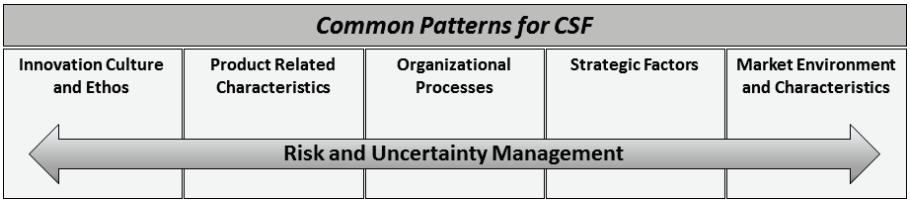

Figure 2: Common pattern for identifying CSF (Adapted from [10,11])

A close correlation of technology push to radical innovation as well as market pull to incremental innovation is identified [12]. This correlation shall be used as an initial strategic position for analyzing and developing CSF based on the schematic comparison of both. The following table 1 depicts the interpretation of a comparative analysis of critical success factors for technology push innovations. Even though there is no specific column to identify particular criteria for risk and uncertainty management as depicted in figure 2, these factors are understood to be represented indirectly by the activities of each pattern.

Table 1. Identifying CSF for technology push innovation (Adapted from [9,15,16])

Common Patterns	CSF	Activities
Innovation Culture and Ethos	Innovative culture	Retaining team members with high level of experience
	Inter-divisional communication and cross functional teams	Rewards and recognition to teams
Product Related Characteristics	Superior product performance and quality	Established product development process
	Customer needs orientation	Hear the voice of the customer
Strategic Factors	Project monitoring	Proper communication and commitment to strategy
	Developing and launching within adequate time frame	Clear decision-making
		Leadership through example
	Top management commitment and backup	Management involvement and accountability
		Empowerment of teams
Organizational and Process Structure	Customer orientation	Reducing customer proximity
	Management of core competencies	Adaption of new core competencies for novel technologies
	Project management	
		Proper resource allocation
Market Environment and Characteristics	Focus on Customer	Build in customer feedback before market launch
	Understanding market dynamics	Strategic selection of lead users or pilot industries

3 CONCEPTUAL FRAMEWORK DESIGN

Before developing a complementary TP framework, it is essential to determine the main phases as well as the idea generation within a product development process.

Cooper describes two processes of idea generation, which can be classified as the top-down and bottom-up approach. The strategic selection of market segments represents the classic and most strategic way of idea generation. A selected business segment is analyzed and based on identified customer problems, a road map for new products is established. These new products typically focus on solving the determined customer issues. In contrary, the bottom-up approach introduces ideas which could be generated by sales or service employees with no direct R&D

interaction. Such ideas might turn into smaller projects and depending on their importance to the company's strategic orientation might be integrated into the product development road map [13].

Since TP innovations are typically triggered within a firm's R&D department, and therefore commonly lack potential and initial target markets [14], a combination of both top-down and bottom-up method shall be anticipated as a potential source for idea generation within a TP-approach.

Most of the basic stage gate processes describe a sequential approach in product development, starting from idea scoping until a post launch review, with potential iteration within a stage, but rarely any cross-stage iterations. Whereas, such processes deliver decent performance for well-established technology products and incremental developments, its inflexibility for dynamic markets or TP developments limits these models. In order to avoid design freezes at too early stages, adding flexibility to the process as well as reducing risk can be recognized as major advantages of iterative processes. Considering that each of these factors can be identified and assigned to an iteration cycle, risk and uncertainty become manageable [17].

In addition the DIA (Discovery, Incubate, Accelerate) competency model describes three main sections of managing radical or breakthrough innovations within a firm's product development process [18].

(1) **Discovery** is the first phase describing the basic principle for developing a new high-tech product. Particularly the identification of opportunities, but much more finding and filtering potential technology push innovations are depicted as crucial factors. This first phase will involve a lot of R&D resources, but in addition to the research work a first elaboration of potential fields of application might be conducted as well.

(2) **Incubation** will drive the product towards customer expectations. It is identified as the biggest part of the DIA model as concept models will be analyzed, tested and redirected towards previous stages for improvements or adaptions. Ensuring proper test methods and conditions, a preliminary market and business model should be available in addition to the prototype technology.

(3) **Acceleration** is the competency of gaining business and sales. No more product development or even research is performed, the focus is clearly put on winning business, building up sales forecasts and becoming profitable.

During the development of the model the interaction and balance of these three dimensions is regarded as essential for a successful management of future business platforms. By adapting the DIA model through implementation of sequential and iterative cycles a comprehensive TP framework is developed to extend a firm’s product development processes.

Based on the different phases of the DIA model, it is supposed that the key aspects of successful TP innovation management are located within the first two sections - discovery and incubation. These early stages of the innovation process can be classified as decisive for future product success. The better this fuzzy front-end of innovation can be managed, the lower the uncertainty and risk levels [19]. Additionally, the implementation of both procedures of sequential and iterative cycles within the framework is considered vital to reduce risk and uncertainty as well as to include the possibility for product adaptions and reviews.

The interfaces between the DIA competencies are recognized as critical factors, indicating that insufficient handover will cause errors or system imbalance [18]. Therefore it is expected, that overlapping these competencies will strengthen the system balance and guarantee a proper handover scenario, especially during the transition from incubation to acceleration.

The distinctive focus of the framework depicted in figure 3 is to systematically embed customers and elaborate success specifications for the potential future product, before the actual product development processes start.

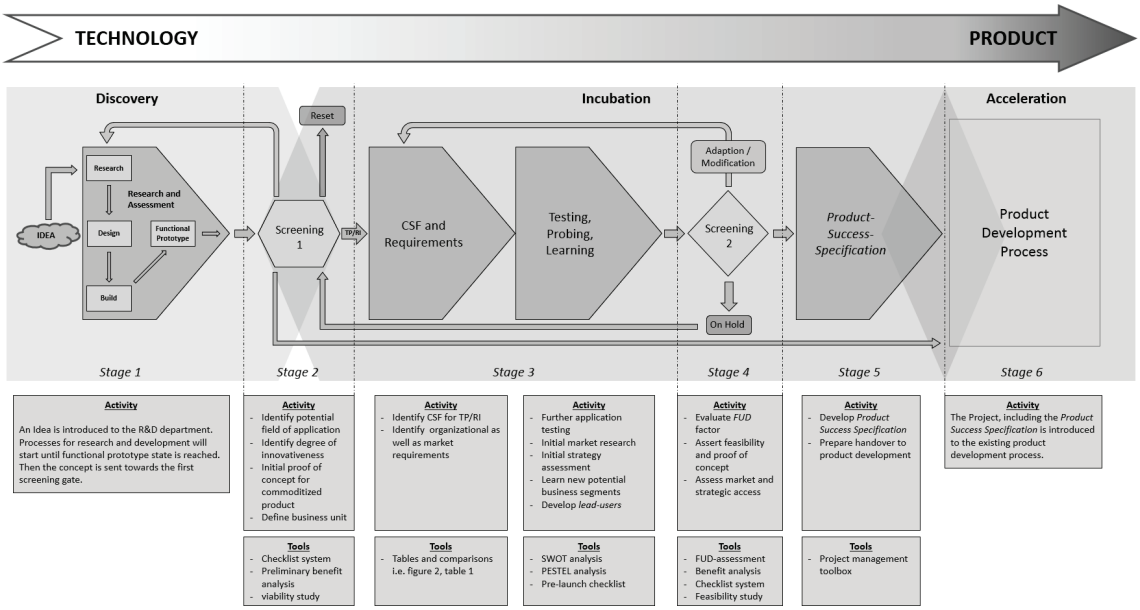

Figure 3: Comprehensive TP framework

4 IMPLEMENTATION AT FRONIUS INTERNATIONAL GMBH

The **first implementation and partial verification** of the TP framework is currently being realized by the Perfect Welding Division of Fronius International GmbH, an innovation leading company. The first steps required several adaptations to Fronius' product development processes in order to be supplemented by the TP framework during the incubation phase. Such modifications as well as the new product development approach have been used to evaluate several ongoing TP projects.

The **discovery phase in stage 1** of the framework is already established as a pre-development unit within Fronius' research and development department, which is the sole source of new TP concepts. Driven by this R&D group, an idea is processed through various research stages until a functional prototype is ready. This prototype will then be introduced to **stage 2, the first screening gate** for evaluation of the potential fields of application. This business gate consists of a small committee with members of strategically important departments like sales and marketing supported by senior members of the responsible R&D development team. The main focus is to objectively identify the degree of innovativeness as well as potential fields of application for the new technology. Additionally, the initial proof of concept ensures that only feasible technologies are introduced.

One of the major findings during the validation of this stage was that future committees should be expanded by incorporating more employees which are not directly linked to the business division or even the project team that drives the new technology. This will foster more neutral decisions and makes sure to identify common fields of interest for Fronius' other business divisions at an early stage.

Once the screening gate is passed, the TP project reaches **stage 3** where it is necessary to understand the projects **degree of innovativeness** and the **presumed CSF**. In the case of the development of a new battery powered welder, this stage represented a more organizational focus than a market orientation. Driven by the sales development department structural as well as product related requirements were identified before the project moved on to the next stage.

In contrary to the previous section, the **testing, probing, learning phase of stage 3** is now focused on customer respectively market requirements. At this point in time there are two projects located within this section of the TP framework. On one hand Fronius is evaluating a potential revolutionizing pre-treatment technology together with strategic partners in order to gain

further market information. Potential target markets are being evaluated through tests on prototype machines, customer visits and further application research. In parallel future business strategies are composed based on the knowledge gained during this stage. On the other hand, a second project lead by Fronius' sales development is focusing on a new inverter technology, which is considered to offer substantial savings due to advanced energy efficiency. Even though it was identified, that some of the criteria for this TP innovation were not as predominant as expected, the overall perception of risk and technological novelty points towards a TP approach. During the assessment of the project's progress and scope of work, the actual position within the TP framework was identified to be located in the testing, probing, learning segment. As a result the project was expanded involving first lead users to initiate market research and even future product strategy developments.

During the ongoing validation of this broad stage it was realized that evaluating the organizational requirements and competencies is of utmost importance. It is necessary for Fronius to understand if and how the current organization can handle a TP project and where changes or adaptions are need. Only if the internal structure can adequately handle a new TP innovation, the step towards approaching the market can be made. This leads to the conclusion that for all future projects an appropriate organizational evaluation will be embedded as a first step of stage 3.

After the project successfully passed the first 3 phases of the framework **stage 4 represents a second screening gate** to evaluate the maturity stage of the TP project. In case of Fronius' pre-treatment project the preparation for this screening gate is already in progress. The main focus for this first iteration will be to assess whether the suitable market segments have already been identified based on the experience and findings of the previous stages. Again, sales and business development will play a major role during this evaluation, since the product tests will be supported with additional market research data such as questionnaires and classic market research.

The incubation section is finished with **stage 5** and the handover of a **Product Success Specification** document to the **established product development process** of **stage 6**.

In addition to the implementation of the framework solely for TP projects, Fronius' strategic management department initiated a generic evaluation in order to determine whether an implementation of such a comprehensive framework besides a standard product management environment is feasible.

5 CONCLUSION

The consolidated findings of this research point out that risk and uncertainty can be considered as omnipresent factors of technology push innovations. As soon as these characteristics, besides the common CSF, can be reduced, the potential of commercial success can be increased.

The developed complementary framework described, focuses on the specific boundary conditions of TP innovations and the evolution of a technology idea towards a product concept with an iterative approach. This ample process sequence will allow an improved handling of technology concepts towards a successfully commercializable product and ensures a proper market and technology assessment within an early stage of the overall product development process.

REFERENCES

[1] Herstatt C., Lettl C. (2000): Management von technologiegetriebenen Entwicklungsprojekten, Arbeitspapier 5

[2] Vahs D., Burmester R.(2002): Innovationsmanagement, Von der Produktidee zur erfolgreichen Vermarktung, Schäffer-Poeschl Verlag Stuttgart, 2. Auflage, p. 79

[3] Goffin K., Mitchell R.(2010): Innovation Management, Strategy and Implementation Using the Pentathlon Framework, Palgrave Macmillian, 2nd Edition

[4] Kohnhauser V., Pollhamer M. (2013): Entwicklungsqualität, Carl Hanser Verlag, 1. Auflage

[5] Hauschildt J., Salomo S. (2011): Innovationsmanagment, Verlag Franz Vahlen GmbH, 5. Auflage

[6] Gaubinger K., Schweitzer F., Zweimüller R. (2012): A commercialization process model for technology innovations, XXIII ISPIM Conference
[7] Cooper R. G. (2006): The seven principles of the latest Stage-Gate method add up to a streamlined, new-product idea-to-launch process, Marketing Management/Stage-Gate International
[8] Zwikael O., Globerson S. (2006): From Critical Success Factors to Critical Success Processes, International Journal of Production Research, Vol. 44, No. 17, p.2
[9] Stern T., Jaberg H. (2010): Erfolgreiches Innovationsmanagement, Erfolgsfaktoren - Grundmuster - Fallbeispiele, Gabler Verlag, Springer Fachmedien Wiesbaden GmbH, 4. Auflage, pp.10-11
[10] Henard D.H, Szymanski D.M.(2001): Why Some New Products Are More Successful Than Others, Journal of Marketing Research, Vol. 38
[11] Kühnl Ch.(2010): Erfolgsfaktoren im Innovationsmanagement, Eine empirische Betrachtung aus Hersteller- und Anwendersicht, Gabler Verlag, Springer Fachmedien Wiesbaden GmbH, 1. Auflage
[12] Tripathi S. S., Guin K. K., De K. S. (2012): Critical Success Factors for Marketing a New Product: An Empirical Investigation, The Indian Journal of Management, Volume 5
[13] Cooper R.G.(2002): Top oder Flop in der Produktentwicklung, Erfolgsstrategien: Von der Idee zum Launch, Wiley-VCH Verlag GmbH, 1. Auflage
[14] Schwery A., Raurich V.F.(2004): Supporting the technology-push of a discontinuous innovation in practice, R&D Management 34, Blackwell Publishing LTD
[15] Cooper R. G., Kleinschmidt E. J.(2000): New Product Performance: What Distinguishes the Star Products, Australian Journal of Management, Vol. 25
[16] Papies S.(2006): Phasenspezifische Erfolgsfaktoren von Innovationsprojekten, Eine projektbegleitende Längsschnittanalyse, Deutscher Universitäts-Verlag GWV Fachverlage GmbH, Wiesbaden, 1. Auflage
[17] Ungera D., Eppinger S.(2011): Improving product development process design: a method for managing information flows, risks, and iterations, Journal of Engineering Design Vol. 22
[18] O'Conner, Gina .C. (2009): Sustaining Breakthrough Innovation, Research Technology Management, Industrial Research Institute Inc.
[19] Gaubinger K., Werani T., Rabl M.(2009): Praxisorientiertes Innovations- und Produktmanagement, Grundlagen und Fallstudien aus B-to-B-Märkten, Gabler GWV Fachverlage GmbH Wiesbaden