Approach for identifying and initially assessing radical product ideas

A company-based foresight management tool for radical innovation

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***Abstract*: Radical innovations have become an important feature on companies' innovation radar. Since the design process for radical innovations is still a fact many companies struggle with, this paper presents a solution for how to handle radical product ideas during idea management processes within the early phases of the design process. With this in mind, a tool for identifying radical product ideas in those early phases has been developed. In detail, the paper presents the introduction process for such an identification tool. Additionally, the implementation in a German company from the consumer industry is described. Furthermore, an initial evaluation of the tool by experts is presented.**

Keywords: Radical product ideas; radical innovation; idea process; idea management; front end of design process; early phases of a design process

I. INTRODUCTION

Creating radical innovations has been deemed essential for a company's long-term success in various papers during the past decade [1–4]. Radical innovations constitute particularly innovative products. However, as emphasized in [5], recognizing the importance of radical innovations and successfully developing and commercializing them are two different tasks.

A. Motivation

The motivation for publishing this paper is to present an approach for identifying ideas in the early phases of a design process for radical innovations, i.e. new product ideas which are expected to be radical. As indicated at the beginning of this section, the development of radical innovations needs to be different to incremental innovations [5–7], i.e. different approaches and methods are necessary [8, 9]. As a result of our past research, different problems encountered while trying to develop radical innovations were analyzed [10]. However, even if a differentiation in design activities between radical innovations and incremental innovations is claimed – so-called ambidexterity [11, 12] – companies must first determine whether a new idea might lead to a radical innovation, and must therefore be treated differently during design processes. The necessity of such an identification step has been discussed in depth in [8]. In order to emphasize this necessity, two insights from industry experts are presented briefly. The first insight put forward by the authors originates from an expert group working in the Research & Development department at a German company in the consumer industry. During different exchanges of views with these industry experts, they claimed that no differentiation between radical and incremental ideas exists at their company. The same tools are thus used for assessing incremental and radical ideas. In practice, radical ideas are rejected because they are often assumed to be too risky. Only low-risk ideas which mostly constitute incremental ideas were followed up in most cases.

Another expert from the Central Innovation Management of a major German automotive supplier claims that it is not possible to compare the development of the twentieth generation of a needle bearing with the development of a truly new idea, where neither distribution channels, expertise, suppliers nor a customer exist. An initial step is required during the idea management process which involves channeling initial ideas according to their degree of novelty. Developers must approach the radical ideas identified in this manner in a different way to incremental ideas.

In both case studies, a step is required for identifying radical ideas which, firstly, channels the different types of ideas and, secondly, shows why an idea is radical or not, and what must be observed or can be viewed as a new opportunity. The present paper discusses how such an identification step may look and how it can be conducted during idea management processes in the early phases of design processes. Additionally, the introduction process of the tool is presented.

B. Problem statement and research question

As intimated in Section A, the research focus lies on a tool which supports designers in defining new product ideas as either radical or not radical. To develop a clear understanding of radical ideas, those ideas should be described as product ideas, which are ideas for a radically

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new or a radically adapted product. Thus, a radical product idea should be defined as the precursor of a radical innovation [13]. In other words, a radical innovation is the successful implementation of a new radical idea [14].

Initial research studies have shown that the term "radical idea" does not have a uniform definition [13], and companies have to define their own understanding of the term "radical." Based on that vague understanding, criteria adapted to the nature of different companies have to be defined which can form a fundamental step of identifying radical ideas. Consequently, the main research question of this paper is defined as follows:

> Which criteria can be used for an identification step of radical product ideas in industrial practice at an early stage in design processes?

By answering this research question, the following goal should be achieved.

C. Goal

The goal of the paper is to present a tool for identifying radical product ideas and to demonstrate its support effect for designers. Based on two earlier papers [8, 13], the tool in question should not only be presented, but also tested and evaluated by a group of experts. The following hypothesis for the previously presented research question therefore has to be proven within this paper:

> Radical product ideas can be successfully and efficiently identified by a systematic tool which is based on defined and company-specific criteria.

By proving this hypothesis, the presented and applied procedure for forming such an identification step should also be evaluated. The reason why radical ideas have to be identified during early phases of the design process is that their treatment during design processes should be consciously different. It is thus necessary to make it apparent that the channeled radical ideas are indeed radical. Therefore, different methods during the design process might be used compared to incremental ideas. However, another important reason for performing such an identification step is the open communication of the "radicalness" of an idea. Risks, warnings and opportunities alike must be made apparent for everybody in the company due to the criteria used.

II. Relation to Existing Theories and Work

In order to give an overview as to which existing theories and research work this paper contributes, several insights and perspectives from literature are discussed.

For this overview of the pertinent literature, two main aspects have been examined: What is the understanding of the term "radical," specifically when used for ideas in the pertinent literature, and how are radical ideas defined (Section II.A)? Additionally, analysis must be conducted as to which conventional suggestions for the treatment of radical ideas during idea management steps already exist (Section II.B). As the tool for identifying radical ideas presented in this paper also contributes to foresight processes, a section on foresight processes and tools is added at the end of this section (Section II.C).

A. Understanding of the term "radical" within design processes

In order to deliver a broad understanding of the term "radical," this section is split into two subsections. The first deals with the definition of the term "radical innovation," which is much more frequently used than the term "radical idea." Since an innovation is the result of a successful implementation of a new idea, we try to differentiate within the understanding of a radical innovation and a radical idea in the second subsection of II.A.

1) Definitions of radical innovation

It first has to be mentioned that various definitions and perspectives on the phenomenon of radical innovation and its synonyms (e.g. "breakthrough innovation" [15], "discontinuous innovation" [16]) exist [5, 17–21]. A radical innovation can be defined for the purposes of this paper, according to [22], as a change to the existing service offer which is based on a new technology or a new product architecture. This innovation causes a change on the market by developing new product categories or by changing industry-specific rules [22]. However, irrespective of which definition is used for characterizing radical innovations, one point exists which all definitions should have in common: The term radical innovation has to be considered from several dimensions [8, 10]. For instance, from a business perspective, radical innovations may constitute a completely new innovation or an adapted existing innovation which includes a new technology, for example. This can change the market by surpassing competitors and rendering existing products obsolete. From a customer's perspective, a radical innovation constitutes a product which is totally unknown, and which can change familiar utility models [10].

In contrast to radical innovations, incremental innovations use existing technologies, and provide almost the same benefits as existing products. They are often referred to as an adaptation or enhancement innovation [12]. According to [23], incremental products can be defined as modifications of existing products. They are designed to satisfy a perceived market need, and can be expected to require a relatively short development time compared to radical innovations [23].

Although various prose definitions exist for radical and incremental innovation, it is difficult to use these definitions in order to elaborate an identification tool for radical ideas. For this reason, we will refer to a criteria-based understanding of radical ideas in the following sections, as opposed to prose definitions.

2) Understanding of radical ideas

Since this paper differentiates between innovation and its preliminary idea stage, the understanding of a radical idea is the main aspect we will discuss in this section. As we analyzed in [13], a prose definition of the term "radical idea" is very rare in the pertinent literature. This is one reason why we named this section "understanding" and not "definition" of radical ideas. Another reason is that, according to [15],

who claim that an object is better described than defined, it is not always possible to create an all-encompassing definition of a specific term for each business, company, industrial sector or specific application. As radicalness must be understood from different perspectives, which was a contention in the preceding section, a differentiated understanding of radical ideas is thus fundamental.

In [13], a systematic literature review on the understanding of radical ideas was performed. The main results of [13] will be presented according to the following paragraphs. One of the most important criteria for describing radical product ideas is the degree of novelty, which must be considered from different perspectives, such as the technological content that is new for the user, new for a market or a market segment, or for the designers who have to deal with a new technology. However, different and new organizational structures within the company should be taken into account when talking about radicalness, and not merely technological aspects.

Several scholars use the degree of (new) knowledge for defining radicalness. More new knowledge is required for radical innovations than for incremental innovations [24, 25]. Uniqueness, a high degree of originality and a potential reduction of costs can be cited as further criteria. Furthermore, if the product idea serves as a basis for new technologies, future products, services or business development, or it can be viewed as a challenge base for the existing technological order, then that idea can be defined as radical. A radical product idea enables a high improvement in performance, delivers extremely good value or is based on fundamentally new scientific research. From a user's perspective, different criteria exist which can declare an idea as being "radical," such as the opportunity to enable people to do things they have never been able to do before or making a meaningful difference in people's lives. A radical idea might be able to create new categories, species or classes of products. It can lead to the obsolescence of existing products and create a previously unrecognized demand among consumers. Another characteristic might be that there is no existing market for such an idea so far, and that the market is to be created or reconstituted [13].

Other criteria were analyzed which affect the companies' inner processes, such as the novelty of the product development process, longer time-frames, high complexity, high uncertainty, high costs, high degree of risk, originality, organizational changes and the effects on a company's competitive position or strategy [13].

Besides all these criteria, the point in time when an idea is declared as radical is additionally discussed in [13]. The degree of maturity plays an important role since some of the aforementioned criteria are difficult to assess if the idea has the status of a first single sketch. In addition, the assessment of criteria might change during the development and evolution of the idea, as may the growth of information and knowledge about the idea. During development, a radical idea can become an incremental idea, and vice versa. All of these aspects have to be taken into account while developing a tool for identifying radical ideas during idea management processes. Therefore, a radical idea and a radical innovation should be characterized by a list of criteria which describe it in depth [13]. This criteria-based description forms the basis for an identification tool. The description will be presented in Section IV.

B. Treatment of radical ideas in idea management processes

Since this paper relates to the assessment of ideas, and therefore the management of ideas within the field of innovation management, some theories on idea management and its process relating to radical ideas will be presented in the following section. Firstly, a general overview of idea processes is presented. Secondly, insights into the special treatment of radical ideas discussed in literature are described.

1) Analysis of general idea management processes

The idea management process (hereafter referred to only as the "idea process") is seen as a process which starts with the creation of new product ideas and ends with the selection of one of these ideas. This idea is chosen for performing further steps of the design process. The idea process is part of the planning step of the product development process [26]. It is usually implemented before a detailed design specification is developed.

Different scholars in the pertinent literature propose a systematic process starting from the initial step of idea creation and ending with the realization [26–34] in order to conduct idea management.

The most important similarities and differences of these processes are analyzed in [35]. In order to summarize these results, Fig. I shows a generic idea process by [35]. The process description normally starts with the steps of idea creation and idea capture. After that, most of the approaches use one to three evaluation steps. Irrespective of how many evaluation steps are recommended, an evaluation step is always a milestone where a decision is made as to whether the ideas can pass the milestone, or whether they must be rejected or stored in an idea storage pool [28–30]. The degree of detail of the idea description increases after every gate, while the degree of detail of the evaluation criteria also increases with every further evaluation step [27, 28, 30, 33].

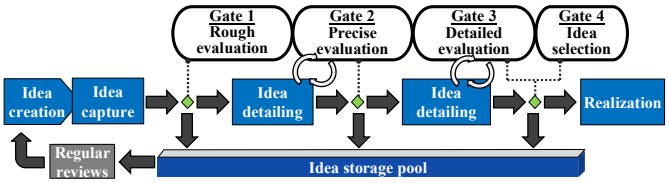

Fig. 1. General idea process [based on 35]

2) Approaches for the treatment of radical ideas in idea processes

This subsection will analyze different approaches and recommendations for the special or differentiated treatment of radical product ideas during an idea process.

In actual fact, only idea processes for radical ideas exist in the pertinent literature. However, these processes are solely for radical idea processes, and do not differ from general idea processes presented in Fig. 1 in their general structure and their main steps [cf. inter alia 36]. No continuous process exists which starts from the creation of radical product ideas and ends with the realization of an innovation which differs significantly from conventional idea processes [8] and takes both idea types (incremental and radical ideas) into account. Only a few general recommendations exist on how to handle radical product ideas within general idea processes. In [37], the use of TRIZ is recommended for generating ideas in order to develop radical product ideas.

Several recommendations can be found in the relevant literature concerning special treatment during the evaluation steps of radical product ideas. In [38], for example, some rather vague general recommendations concerning how to identify ideas with radical potential during evaluation steps and according to the presented evaluation criteria are provided. Advice is given not to use the criterion "fit to company's innovation strategy" because this is often a rejection criterion for radical product ideas [33]. Radical ideas often require a fundamentally new innovation strategy [39]. Additionally, scholars [33] warn against using minimum return as an evaluation criteria for radical product ideas during a very early evaluation step. Several researchers present warnings [inter alia 12] not to use the same criteria for both incremental and radical product ideas. Incremental ideas normally focus on risk and market prospects; criteria which are difficult to assess for radical ideas. Radical ideas might thus fail to reach the next milestone at a very early stage in an idea process. Therefore, proposals exist to separate radical product ideas from incremental ideas before or during the first evaluation steps [inter alia 12]. As already mentioned in the introduction, the procedure for such a separation, channeling or identification step is actually only described roughly in the pertinent literature, or is based on general recommendations [inter alia 8, 12, 38, 40]. In a previous paper [8], we proposed such a step as "gate 0," to be implemented in existing idea processes. Fig. 2 shows this suggestion. From that gate or milestone onward, radical ideas can be separated from incremental ideas. Both types can be assessed according to their characteristic and adapted criteria.

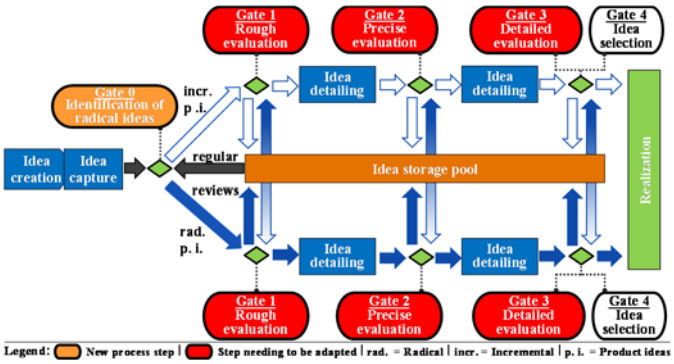

Fig. 2. Idea process [according to 35] with suggested additional and adapted steps for identifying and assessing radical product ideas

This means that all evaluation steps (red gates in Fig. 2) need to be adapted according to the type of idea (radical or incremental). This adaption is not discussed further in this paper. The focus of the present paper is to prepare such a step in detail and to test it in industrial practice. The procedure for elaborating such a step is also to be evaluated. Before doing so, one last research field that this tool will contribute to should also be noted. Since idea processes form part of innovation management, which is very closely connected to corporate foresight processes [41], a deeper understanding of this research topic should be created in the following sections.

C. Current understanding of foresight processes

According to [42], foresight is essentially a human capacity that can be seen as a competitive advantage, cultural renewal and a major source of wisdom. Foresight includes different perspectives, and it is difficult to provide a unique definition [41]. Furthermore, foresight is used to describe activities which deliver forward-looking information bases. The term refers to approaches which support decision-making steps by delivering input concerning the long-term future [43]. Foresight processes are summarized as strategic or corporate foresight if they are used in a corporate context [44]. In [41], several definitions of corporate foresight are proposed and analyzed. As an operational definition for this paper, and according to [41], corporate foresight can be seen as the ability to recognize trends and developments from a medium- and long-term perspective. Based on that, the relevance for the company can be interpreted, and appropriate actions for generating competitive advantages can be initiated [41]. According to [45], the functions of corporate foresight are threefold: Firstly, the preparation of strategic decisions; secondly, the long-term protection of entrepreneurial competitiveness; thirdly, the permanent reinforcement of a company's learning ability and innovation capability [45].

This paper contributes to all three of these aspects. The presented tool will support steps related to the strategic decision. Consequently, the goal of all future and trend research tools is to provide decision-making aids in an uncertain corporate environment [46]. This is the main aspect to which we wish to contribute. However, the two other aspects should also be addressed, while more radical ideas should be promoted by the disclosure of risks and warning signals triggered by the presented tool. In the course of this, the innovation capability will be reinforced if the innovation culture is positively affected, i.e. if radical ideas gain more managerial support.

The specific issue of foresight processes in radical innovation is quite a new research field. Several tools, e.g. those proposed by [47, 48], have been presented in the more recent past. Most of these tools are used to identify radical innovation ex post. These tools thus declare innovations as radical or not once the innovation has already been launched onto the market. Other tools which deal with the identification and channeling of radical ideas are still outstanding [10, 49] and confirm the need for the tool presented in this paper.

III. RESEARCH APPROACH

In this section, the methodological framework of the paper will be briefly outlined, in addition to the method and procedure for reaching the presented goal.

A. Methodological framework of the paper

The research work of this paper is based on the Design Research Methodology (DRM) according to [50]. The DRM will serve as the methodological foundation for this paper. The first step of DRM, i.e. the Research Clarification, is presented in Section I, while the research need has also been presented in an earlier paper [8]. The Descriptive Study I, which forms the second part of DRM, has been addressed in Section II, particularly in Subsection II.B. This part was also shortened. Detailed investigations can be found in [8]. These studies show a deeper understanding of how radical ideas are treated in idea processes. Additionally, it is shown how radical ideas can be defined, and which criteria can be used to define them (see Section II. A and [13]).

In the following section, the development process of the tool – referring to the procedure and the implementation for the identification step of radical ideas – is presented (Section III), which forms the third part of DRM: the Prescriptive Study. The elaborated tool was tested and evaluated by industrial experts. The evaluation of the tool and the results obtained in this manner form the fourth part of DRM, the Descriptive Study II (Section IV).

B. Method and procedure

For the elaboration of the identification tool, the following procedure was performed. Firstly, a list of criteria which describe and characterize radical ideas most effectively was derived. This list was elaborated in a systematic literature review and first presented in [13]. This set of criteria was derived according to the four main dimensions published in [8], where the first initial idea of this identification step was presented (see Fig. 3).

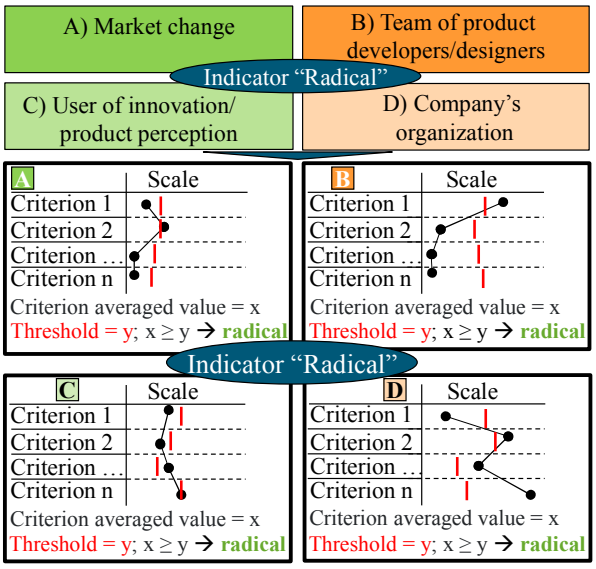

Fig. 3. Considered dimensions and framework for the identification step [8]

The criteria were thus classified into a micro- and a macro-perspective, which are represented by the four dimensions (see Fig. 3).The dimensions "Market change" and "User of innovation/product perception" characterize the macro-perspective, whereas the micro-perspective concerns the dimensions "Team of product developers/designers" and "Company's organization." The lists of criteria used are shown in Tables I and II. These two lists can be used to develop a criteria-based understanding of radical ideas within a company. The next step involves the selection and definition of specific criteria for the company, represented by designers or idea managers, according to the question of which of these general criteria are relevant for their company and which they would deem to be relevant and necessary. To make such a choice, the number of chosen criteria should be manageable and clear. Additionally, the criteria have to be described in a comprehensible and explicit manner, so that everybody using those criteria will have the same understanding. Subsequently, a scale is needed which represents both non-radical and radical measurement aspects. For example, if the degree of required new knowledge for the implementation of an idea is zero, then the idea is not radical based on the measurement of that criterion. What follows is the definition of thresholds. According to Fig. 3, thresholds for each criterion have to be defined according to the scales determined previously. Therefore, the tool is ready for use. However, the thresholds should be checked and adapted from time to time if necessary.

TABLE I. CRITERIA DEFINING RADICAL PRODUCT IDEAS FROM A LITERATURE PERSPECTIVE (COMPANY´S MACRO-PERSPECTIVE)

	Addressed dimension	CRITERION: "Idea is defined by/based on/delivers/enables…"
Macro-perspective (company-external perspective)	Market	a challenge base for existing technological order.
		the creation of a new market or reconstitution of an existing market.
		the fact that a market for such an idea is non-existent.
		a basis for new technologies, future products, services and/or business development.
		new fundamental scientific research.
		a high degree of novel technological content.
		a high degree of new knowledge.
		a recombination of existing knowledge from several knowledge domains.
		uniqueness.
		the obsolescence of existing products.
		the potential to create new categories, species or classes of products.
		high improvement in performance (by a factor of 5 to 10).
		a high degree of originality.
		extremely good value.
	User/ customer	potential reduction of cost.
		a meaningful difference in the lives of people.
		a previously unrecognized demand among customers.
		people to do things they have never been able to do before.

TABLE II. CRITERIA DEFINING RADICAL PRODUCT IDEAS FROM A LITERATURE PERSPECTIVE (COMPANY´S MICRO-PERSPECTIVE)

	Addressed dimension	CRITERION: "idea is defined by/based on/delivers/enables…"
Micro-perspective (company-internal perspective)	Team of designers	a challenge base for existing technological order.
		high complexity.
		new fundamental scientific research.
		high improvement in performance (by a factor of 5 to 10).
		uniqueness.
		high degree of novel technological content.
		high degree of originality.
		high degree of new knowledge.
		a recombination of existing knowledge from several knowledge domains.
		a basis for new technologies, future products, services and/or business development.
		the potential to create new categories, species or classes of products.
		the obsolescence of existing products.
		potential reduction of cost.
		long time frames.
		high uncertainty.
		high costs.
		a high degree of risk.
	Company's organization/strategy	extremely good value.
		novelty of the process development project/process changes/adaptation.
		a high degree of change in the existing practices of an organization.
		a transformation of a company's competitive position.
		a basis for strategic renewals.

IV. FINDINGS

The findings represent the results of an initial introduction process for the identification tool in the Research and Development department at a German consumer products company. We applied the same procedure as shown in Section III.B. Our testing experts were a group of seven product designers or innovation managers, four of whom work as division or group leaders.

A. Introduction process for the tool in industrial practice

We started the implementation step by deriving relevant criteria for the company from the set of criteria for radical ideas (Tables I and II). This was done in the course of brainstorming discussions and a vote among the experts.

After that, a clear yet easily comprehensible description of all relevant derived criteria was formulated. The criteria chosen are shown with the description in Table III. Within that example, we introduced a two-tiered measurement logic for the identification step. We opted to perform the first step after the initial emergence of the idea, which is at the very beginning of the idea process, where only a little previous knowledge of the idea is available. A second measurement step should be performed at the end of the idea process step, where the idea is more mature and detailed, while an initial list of requirements can be defined based on the amount of information.

The actual tool is a spreadsheet program similar to Microsoft Excel, in which the user can enter a value according to their assessment for each criterion. For the first measurement step, we used the criteria "Level of novelty," "Risk disclosure," "Level of benefit" and "Potential for market change." The latter also includes new market creation. We used a five-tiered scale to define a measurement logic according to the criteria-based values. To name one example, we used the following scale for the level of novelty. Fig. 4 shows all scales for the other criteria used in step one.

Not new at all = 0
Less new = 1
Comparatively new = 2
Highly new = 3
Absolutely new (no commonalities with other products) = 4

For the second step, we detailed the measurement logic of step one by using more criteria in each dimension. The criteria used for all four dimensions are shown in Table III. We used the same logic for the scales as in measurement step one, therefore we first specified the criteria using a general, unambiguous description and classified the different possible forms of the criteria using a five-tiered scale, as in step one.

After this procedure, we interviewed 20 experts within the Research and Development department of our partner company in order to define thresholds for steps one and two. We discussed the average of the suggestions for the threshold of the experts with the core team of our partner and defined the thresholds according to the questions (see Fig. 4 for step one).

I. Technology

Level of novelty:
The present product idea is characterized by a certain novelty. This novelty primarily addresses technological aspects within the company.
Not at all new = 0 | Less new = 1 | Comparatively new = 2 | Highly new = 3 | Entirely new (no commonalities with other products) = 4 | **Threshold = 2.5**

II. Company

Risk disclosure:
There is a certain risk associated with the implementation of the product idea (resources, supplier, project management, uncertainty, effort).
No risk = 0 | Low risk = 1 | Average risk = 2 | High risk = 3 | Very high risk = 4 **Threshold = 3**

III. Customer

Level of benefit:
The product idea is characterized by a certain benefit for the customer brought about by new functions.
No new benefit = 0 | Low benefit = 1 | Average benefit = 2 | High benefit = 3 | Very high benefit = 4 **Threshold = 2**

IV. Market

Potential for market changes:
The product idea has a certain potential to change the market or to create a new market, if it results in a successful innovation.
No potential = 0 | Low potential = 1 | Moderate potential = 2 | High potential = 3 | Very high potential = 4 **Threshold = 3**

Fig. 4. Criteria of measuring step I of the identification step

We subsequently performed an initial measurement with a recent example of a company's product which has already been launched onto the market. However, the idea's evolution before it became an innovation was remarkably well documented, and the core team of our partner was involved into the project. Therefore, all parties were able to discuss the performance within this project and the evolution of the idea. Based on this, the core team subsequently used

the measurement tool for step I and II by filling out the spreadsheet. The initial results analyzed in the form of a bar chart are shown in Fig. 5 and 6.

In Fig. 5 and Fig. 6, the thresholds are represented by the red line in each case. The columns show the rating given by the experts as a group consensus. In the first step, the level of novelty for the team of designers was determined as radical, while the risk identified at this point in time was assessed as being incremental. From a macro-perspective, the product idea delivers a radical level of benefit, while the estimated potential for market changes is identical to the threshold.

TABLE III. CRITERIA OF SECOND MEASUREMENT STEP

Team of designers	Company's organization/ strategy	User/customer	Market
Level of novelty	Risk disclosure	Level of benefit	Potential for market change
Level of uniqueness	Level of internal resistance	Potential for a user's positive feeling	Potential for creating new markets
Necessary extension of internal knowledge	Level of expenditure	Potential for a unique selling proposition	
Barriers for acquisition of external knowledge	Level of entrepreneurial opportunity	Level of the benefit of change	

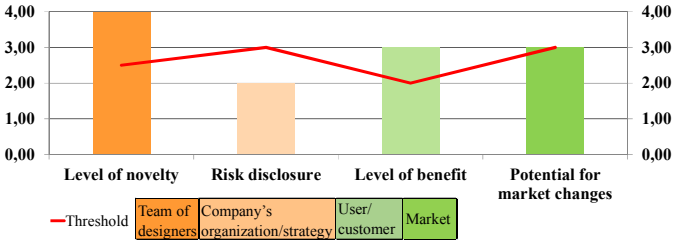

Fig. 5. Analysis of the first measurement step

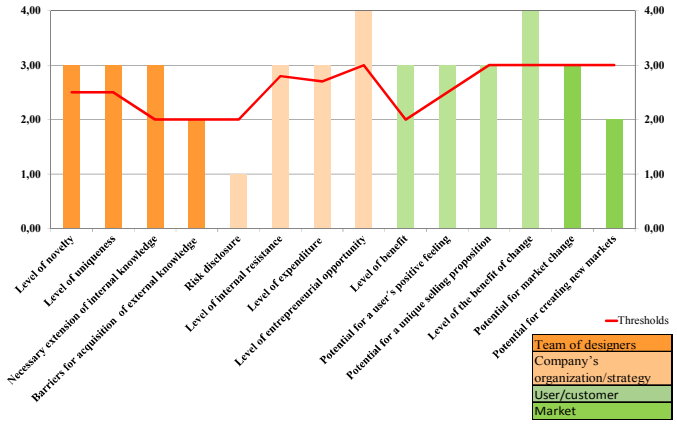

Fig. 6. Analysis of the second measurement step

The analysis of the second measurement step shows a slightly different view of the idea. First of all, it can be ascertained that the assessment by the team of designers (dark orange columns) is still radical. However, the values dropped within the whole spectrum of the dimension. Additionally, nearly all factors representing the radicalness from the perspective of a company's organization or strategy (light orange columns) increased. The experts explained these two phenomena with the fact that the design team did not encounter significant problems while implementing a solution, although the technology was quite new. However, the strategic and organizational steps to be conducted increased in number. Unforeseen problems and challenges also appeared, which were justified by the fact that inadequate methods were used, or that warnings and challenges were ignored. The other columns, which represent the macro-perspective (green columns), did not change dramatically. Only the level of the benefit of change emphasized the benefit for the user/customer.

B. Supporting evaluation of the tool

After the initial development of the tool, the core expert team (seven people) was asked to evaluate the final tool. For this purpose, an evaluation sheet was used, whose content is shown in Table IV. Different evaluating questions were asked concerning the structure of the measurement steps, the criteria, scales and thresholds, and the method itself. For answering the questions, a five-tiered Likert scale (agreed – disagreed) was used. As the tool's "final" status has not been achieved so far, this evaluation can only be viewed as a supporting evaluation, the results of which are also shown in Table IV.

TABLE IV. RESULTS OF THE SUPPORTING EVALUATION OF THE IDENTIFICATION TOOL

	Agreed				Disagreed	N/A	Ø
Measurement steps:	Answers/percentage of answers given						
The two-stage process of measurement makes sense to me.	7/100%	0/0%	0/0%	0/0%	0/0%	0/0%	1.0
The measurement steps fit the company's situation and could be implemented in the innovation process of our company in the existing form.	5/71%	2/29 %	0/0%	0/0%	0/0%	0/0%	1.3
Measurement criteria:	Answers/percentage of answers given						
I think the measurement criteria of the first measurement step are complete. There is no missing important aspect.	6/86%	1/14%	0/0%	0/0%	0/0%	0/0%	1.1
I think all measurement criteria in the first measuring step are chosen and described logically.	5/71%	2/29%	0/0%	0/0%	0/0%	0/0%	1.3
I think the measurement criteria in the second measuring step are complete. There is no missing important aspect.	4/57%	2/29%	1/14.3%	0/0%	0/0%	0/0%	1.6
I think all the measurement criteria in the second measuring step are chosen and described logically.	2/29%	2/29%	2/29%	0/0%	0/0%	1/14%	2.0
The threshold values of all criteria have been chosen logically.	0/0%	5/71%	2/29%	0/0%	0/0%	0/0%	2.3
The scales were logical and comprehensible for all criteria.	0/0 %	2/29%	4/57%	0/0%	0/0%	1/14%	2.7
All measurement criteria were comprehensible everywhere.	2/29%	3/43%	2/29%	0/0%	0/0%	0/0 %	2.0
All measurement criteria fit the company.	3/43%	4/57%	0/0%	0/0%	0/0%	0/0%	1.6
All measurement criteria can be easily assessed by the persons who are/would be assigned to use the tool.	1/14%	4/57%	2 /29%	0/0%	0/0%	0/0%	2.1
Measurement method:	Answers/percent of answers given						
By using the measurement method, radical ideas can be clearly "separated" from incremental ideas.	3/43%	4/57%	0/0%	0/0%	0/0%	0/0%	1.6
I can well imagine that the measuring method might be used successfully at our company.	1/14%	6/86%	0/0%	0/0%	0/0%	0/0%	1.9

We rounded the percentage values in Table IV, therefore the sum of the individual percentage values does not always match 100%. Besides the answers and percentages provided, the average and visualizations showing the amplitude (blue line with orange marker) are also demonstrated. The results of the evaluation and all other findings are critically discussed in Section V.

V. Discussion

The first aspect to be discussed is the procedure for introducing the identification step presented in Section III.B. For all experts, the introduction process was clear and transparent. The most important success factor for the introduction process is the end result of the tool and the positive assessment of the tool by the experts themselves. All experts agreed that the tool could be successfully used to separate radical and incremental product ideas (average 1.6). Additionally, the experts agreed on the fact that the tool can be successfully implemented for their company's operations (average 1.9).

Furthermore, with regard to the research question itself, the experts' opinion on the criteria used for identifying radical product ideas has to be discussed. We initially proved the hypothesis that a systematic tool based on defined and company-specific criteria can be used for identifying radical product ideas. As we explained within the paper, a set of general criteria for each individual company is hardly ever feasible. However, we showed that the process for elaborating a company-based criteria list can be successfully passed. In order to answer the research question fully, further tests and evaluations in different companies and industrial sectors will definitely be required. Answering the research question from the perspective of our experts, who represent the specific point of view of their company, the elaborated list can be used for identifying radical product ideas. However, the experts gave some advice on the criteria "Necessary extension of internal knowledge" and "Barriers for acquisition of external knowledge." Some of the experts had problems assessing these criteria, claiming that both criteria are mutually interdependent. Therefore, an improved definition is required for these criteria. Another point of discussion was the dimension of the market and its criteria. Some experts struggled with the necessity of the dimension, particularly the criterion "Potential for creating new markets." Other experts definitely agreed with the necessity of the dimension.

If we consider the two diagrams of measurement steps one and two (Fig. 5 and Fig. 6), chances and risks for the company are shown. For instance, Fig. 5 show the chances for new markets and the chances of the product idea as increasing the customer's level of benefit, while the organizational risks were moderate. The level of novelty can be interpreted as both a chance and risk simultaneously. Fig. 6 shows chances while further detailing the idea (step one → step two). Furthermore, Fig. 6 supports in the assessment of chances and risks on a detailed level. This also earned positive feedback from a product manager who was part of the expert team during the evaluation.

Another result presented in Table IV is the systematic process represented by the two-step measurement logic (average 1.0) and the "fit" of this logic to the company (average 1.3). A detailed view of the criteria, scales and thresholds shows that the experts were quite satisfied with the first measurement step, although the second step needs to be adapted and improved slightly. The expert team agreed that the scales and the thresholds have to be proven by performing a realistic test of new ideas where the benefit of the tool will also be demonstrated.

VI. Conclusion and Outlook

Based on the presented findings and the discussion, several conclusions can be drawn. We performed an initial implementation of identification steps in order to channel radical and incremental ideas in one selected company. The identification in our test company was successfully implemented. However, the evaluation of the step was only performed initially, meaning that further tests with adequate product ideas and in an adequate and real evaluation environment must still be performed. We also gained some suggestions for improvement which will be implemented in future work. After having successfully evaluated the identification step within this first company, other companies of a different nature must be identified in order to evaluate the procedure for introducing such an identification step, and to improve the logic behind the tool and the introduction process in greater depth. Therefore, a broad use in different companies and context has to be achieved and these different perspectives may alter the used criteria.

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