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APPROACH FOR CREATING A REFINED TASK AS PREPARATION FOR A TARGET-ORIENTED IDEA GENERATION PROCESS

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1. Introduction

Innovations of products, processes and business models are necessary in order to gain business success, profit and economic growth [Zhang and Doll 2001], [Gassmann and Kobe 2006], [Grundlach et al. 2010], [Vahs and Brem 2013], [Gackstatter 2015]. Nevertheless, most innovation projects do not produce the desired success and do not lead to profitable products [Verworn 2010], [Gassmann and Sutter 2013]. A study by the Boston Consulting Group also revealed that the majority of companies are not satisfied with the results of their innovation work because it does not provide the expected outcome [BCG 2007]. These facts show that the management of innovation should be, and indeed become, an increasingly important issue in a company's daily work. Innovation management processes are often not adopted in companies properly, however. Especially in small and medium-sized enterprises (SMEs), the innovation process (IP) is often chaotic and confusing [Gassmann and Sutter 2013]. Consequently, their management process for innovation is not structured and does not conform to general rules or methods. Therefore, there are many papers which analyse problems during the IP and give advice by new support methods. Zhang and Doll [2001] as well as Khurana and Rosenthal [1997] declare the beginning of the IP as the most important stage to achieve development success. This paper also targets the early phases of the IP, collectively referred to as the "fuzzy front end" (FFE) [Koen et al. 2002]. This is a dynamic, often disarranged phase, with little general methods and statements [Verworn and Herstatt 2007]. In the FFE, the development of new ideas is one of the main targets. One of the main targets of the FFE is the creation of new ideas for products or technologies. According to Baker et al. [1967], two types of information are required for the majority of ideas in order to generate new ideas:

- Knowledge about a need, problem or opportunity relevant to the company
- Knowledge about a method or technique for the satisfaction of needs and problems, as well as how to benefit from the opportunity [Baker et al. 1967]

So, in the FFE, developers need to have this information because knowing the problems and customers´ needs leads to innovative and successful products [Piller 2015]. This information must be identified at the very beginning of an IP. Khurana and Rosenthal [1997] pointed out that in several companies the communication about the product´s expectation (e.g. choice of market segments, product´s core benefits) is often not satisfactorily. According to Baker [Baker et al. 1967], that information about the problem and the need, hence the expectation in the product, should be documented precisely and provided comprehensively. However, this information is often not provided appropriately, meaning that the need or problem analysis and the knowledge of the benefit of a new product or process are not

defined clearly. This gap between product development (PD) and strategy processes is mostly caused by problems in the exchange of information [Gerhards 2002].

2. Problem statement and research questions

Most of the costs are fixed in the early phases of the IP [Specht and Beckmann 1996]. However, the main importance (time and costs) is not attributed to the FFE of the IP by the top management [Vahs and Brem 2013]. Structured tools and methods do often not exist and the whole phase is unclear, unforeseeable and unstructured [Koen et al. 2002]. This paper deals with the knowledge and information concerning a problem or need that is necessary to support the following idea generation process (e.g. creative technique methods) as part of the FFE. The result of this analysis must be documented precisely. It should be managed in a clearly arranged and standardised way. With this procedure, the information about the task for generating solution ideas is more comprehensible. Therefore, the results of the problem and need analysis lead to more target-oriented solution ideas according to the targets of the strategy management.
For this paper, the research questions (RQ) are shown in Table 1. In section 4.1 the question of what is needed to define a refined task as preparation for the idea generation process (RQ 1) is examined. In section 4.2, an analysis as to which information the task should include to support the phase of generating solution ideas (RQ 2) is presented. How this task and the additional information are passed on to developers and other people working on generating new solution ideas for the given problem using creative methods is discussed in section 4.3 (RQ 3).

Table 1. Research questions

Research question (RQ)		Section answering RQ
RQ 1	What is needed to define a refined task as preparation for the solution idea generation process?	Section 4.1
RQ 2	Which information is necessary to achieve a refined task in order to support the phase of generating solution ideas?	Section 4.2
RQ 3	How could the analysed information given further to the field of generating solution ideas?	Section 4.3

The content of this paper principally consists of six sections: the analysis and description of the existing problem in order to clarify the research issue represent the main content of sections 1 and 2. To develop a wider background and understanding of the problem and to position the introduced method toward existing techniques, the results of the literature screening regarding the state of the art are presented in section 3. Based on this, the research questions are discussed and answered by hypotheses (section 4). The presented ideas and results are summarized and discussed in section 5. A final conclusion and an outlook constitute the end of this paper (section 6).

3. Front-loading the innovation process with a problem analysis

In this section a generic IP is shown and the different phases are discussed to provide comprehensive background knowledge and to clarify the position and classification for this paper.
Several definitions for the IP can be found in the pertinent literature (see [Brandenburg 2002], [Koen et al. 2002], [Verworn and Herstatt 2007], [Cooper 2011], [Gassmann and Sutter 2013], [Vahs and Brem 2013]). According to these, the IP is the transformation of new experiences, ideas or knowledge into a new product to be introduced onto the market. Since the main content of this paper is related to the FFE of the IP, an exact definition and demarcation to other phases are necessary (see section 3.1). Afterwards, the characterisation of sub-steps of the FFE will be presented (see section 3.2). Section 3.3 provides literature information on problem analysis and introduces methods in order to classify the introduced method in section 4.

3.1 The FFE of the innovation process

The IP is often defined as containing two main phases: the FFE of the IP and the PD phase [Miecznik 2013], [Gassmann and Sutter 2013]. Koen et al. [2002] also adds the phase of the commercialisation

following the PD. The PD phase is a formal, well-structured process characterised by a large amount of formalism with a prescribed set of activities [Koen et al. 2002]. It is according to VDI 2221 [1993] or Pahl et al. [2007] divided into the following four main steps: "planning", "conceptual design", "embodiment design" and "final design". These steps form the "back end" of the IP (see Figure 1) which leads into the commercialisation. Those phases will not be discussed further in this paper. Before the PD phase, which normally starts with a requirement list [VDI 1993], some precursors are required. The FFE deals with the creation of new information. Verworn and Herstatt [2007] and also Kim and Wilemon [2002] define the FFE as all activities starting from the first impulse for an opportunity for a new product or a service through to the decision of whether anew project idea is evaluated ready for PD or not. So, a lot of steps need to take place before PD can commence. Depending on the kind of problem or assignment, some issues are necessary and some can be skipped. In Figure 1, the "front end" phase is shown and separated into three stages. In addition, some sample methods or tools supporting these stages are shown. Partial results of the single FFE phase are also shown towards the bottom of Figure 1. [VDI 1993], [Gassmann and Sutter 2013], [Miecznik 2013].

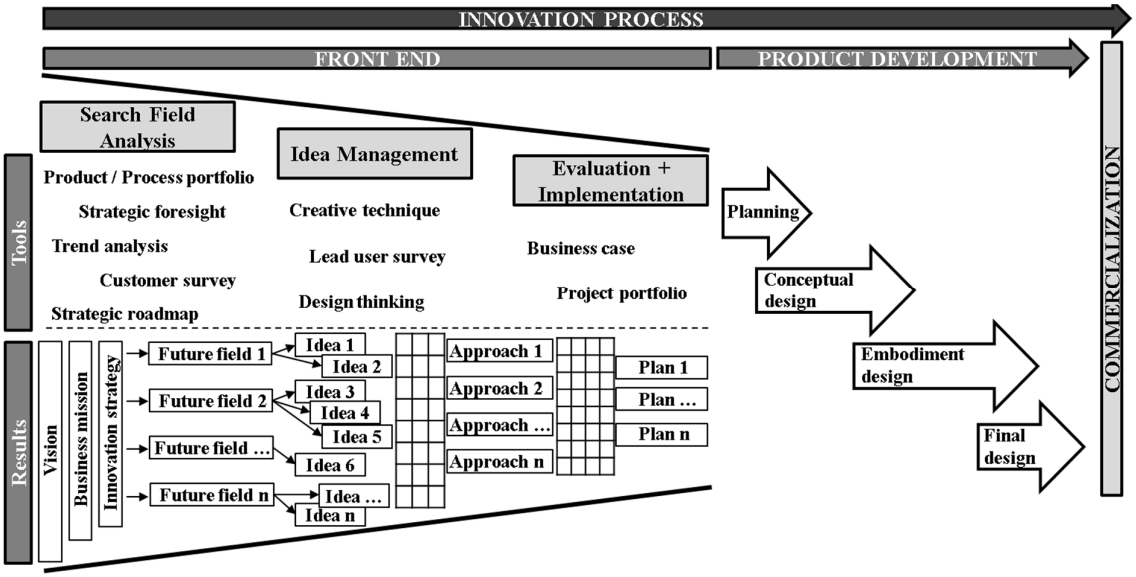

Figure 1. Innovation process according to [Koen et al. 2002], [Gassmann and Sutter 2013], [Miecznik 2013]

During the search field analysis – as the very first stage of the IP – new future and search fields are derived and prelimary opportunities are identified [Khurana and Rosenthal 1997]. Typical tools are trend analysis, strategic roadmaps, scenario planning, product portfolios or market research instruments [Koen et al. 2002]. Afterwards, new ideas are generated, e.g. using creative techniques or customer implementation (lead user surveys) [Koen et al. 2002]. These ideas are evaluated and the best ideas are selected, e.g. by portfolio methodologies or formal idea selection processes, to lead to business cases and project portfolios, which form the third phase of the FFE named "Evaluation and implementation" (see Figure 1) [Miecznik 2013]. To summarise, Figure 1 gives an overview of the different phases of the IP. It should form a clarifying base and explain the separation between the PD phase and the FFE in this paper. Furthermore, it should be mentioned that it is possible that the two main phases overlap and that some sub-steps correspond with others, although this is not discussed further in this paper.

3.2 Interface between search field analysis and idea management

To look into the FFE stage in more detail, the interface between the search field analysis and the idea management, as well as these steps themselves, are discussed in the following section as these phases form the frameworkfor this paper. In the subsequent description, the steps before PD are discussed in an order which leads backwards from the PD. So, the idea management phase is discussed to begin with.

3.2.1 Idea management

Idea management describes all activities to improve creativity, to optimise a required knowledge base, to generate ideas and to transfer ideas to product concepts [Kurz 1998], [Koen et al. 2002]. The main result of idea management is to identify the most promising product ideas which might lead to PD [Messerle et al. 2012]. These ideas are possible solutions for the given task and therefore named solution ideas. According to Brandenburg, they are defined as possible technical principle solutions promising additional potential for new applications [Brandenburg 2002]. However, the suitability of these solutions according to the needs is not proven so far [Lindemann 2004]. An evaluation and selection process follows afterwards (see [Koen et al. 2002], [Messerle et al. 2012]). Before this, the task for developing new ideas is necessary [Vahs and Brem 2013]. Widespread procedures for the detection of new ideas are creative techniques (e.g. TRIZ [Koen et al. 2002])or customer surveys of lead users [Herstatt et al. 2007]. As a basis, employees or customers trying to find new solution ideas need to know about the task. Hence the definition of a problem or a need is necessary. This has already been mentioned in section 1 according to Baker [Baker et al. 1967]. A solution idea is always related to an idea for a special need or a problem. Consequently, the more explicitly a problem or need is defined, the more easily a solution can be found [Riedel and Schraps 2010]. For a well-prepared process for generating solution ideas, the problem, need or task has to be defined properly. According to Kurz [1998], creativity is influenced by an information base, the definition of the problem and the task. The task itself is an intersection between the information base and the definition of the problem. The task – defined in this context as the generation of new solution ideas – is the interface between the information base and the problem, or rather the definition of the problem [Kurz 1998].

It stands to reason that the definition of the problem and the analysis of the need for a new product, just like the creation of an information base, are important for the creativity and influence the solution space for new solution ideas [Koen et al. 2002], [Vahs and Brem 2013].

3.2.2 Search field analysis

Before undertaking the idea management process, the creation and specification of visions, business models and innovation strategies form the first step of the FFE of the IP [Koen et al. 2002] (see Figure 1). The market potential and the risks should be estimated. It is important to use individually defined measured parameters. It has to be considered that a minimum level of fundamental work must be performed before solution ideas can be generated. The medium- and long-term consequences for the company should be proven meticulously [Miecznik 2013].

.How pronounced the search field analysis is, always depends on the problem or need. A future innovation can be expedited by a requirement ("pull innovation") or technology ("push innovation") [Geschka 2005]. A correct innovation strategy is required; one that includes the right technology, product, process and timing strategy. To identify problems, customer requirements, market and technology opportunities, a perennial situation analysis is necessary. Thus the discrepancy between the target stage being striven towards and the actual state leads to new strategies and the target of new product solution ideas to close that gap [Koen et al. 2002]. Vahs and Brem [2013] distinguish between strategic exploration, strategic planning and strategic controlling. Firstly, the resource potential, competences, knowledge, experience, financial assets and environmental influences (e.g. politics, laws, and market trends) are proven. Secondly, future targets and acting alternatives are defined. Current or new markets for the planned innovations are analysed [Vahs and Brem 2013].

By dealing with the possibility and restriction of the innovation strategies, clarity is gained concerning the new tasks [Koen et al. 2002]. During strategic controlling, the distribution of resources takes place for achieving the aspired targets while meeting the planned time and costs [Vahs and Brem 2013].

In summary, it is necessary that the data about the future product is prepared for the subsequent creative process for generating new solution ideas. One main problem which follows the search field analysis is that new product or business ideas are not analysed completely and the current situation is not screened exactly [Vahs and Brem 2013]. As a solution, a need and problem analysis can link the search field analysis and idea management. To simplify the wording, the term "problem" should describe both issues in the following sections – problem and need- because a need is also seen as a problem. In the subsequent section, an approach for a problem analysis (PA) in the state of the art is discussed.

3.3 Problem analysis and preparation

As mentioned before, an interface between the two phases of the FFE – idea management and search field analysis – is necessary to support the idea generation process (section 3.1, 3.2).
There are approaches in literature which recommend such an interface [VDI 1980], [Mencke 2012], although the way this may be accomplished is not described sufficiently; especially the issue of how a PA should proceed in order to provide the best preparation for further tasks. According to Schlicksupp [1992], projects are always different and complex to a varying degree, but every IP needs an impulse (compared to Geschka [2005], see section 3.1.2).
Actually, this impulse can be found in the search field analysis phase, although an exact analysis of this issue is inevitable after this point. Information should therefore be procured and interpreted and the task should be defined to support the solution idea generation process. The necessary appropriateness is often missing which is a weak point in the process sequence. New ideas therefore frequently miss the real problem, and problems are not recorded according to the real significance and with all effects to the company. In this analysis phase, efficient, structured methods which interfuse the issues are usually not used [Schlicksupp 1992].
Additionally to the given background information, various examples for methods concerning a PA especially known from disciplines like the quality management are given. Based on these methods, the introduced concept section 4 can be positioned toward the existing techniques.
Methods for PA are usually used to eliminate the actual/target deviation [Brüggemann and Bremer 2015]. This basic idea is transferred to the connection of problem and solution ideas described in this paper. Examples for PA tools are 8D-reports, problem-decision-plans, the 5 Why method, checklists, Ishikawa-diagrams to analyse the cause and effect connection or tree analysis [Brüggemann and Bremer 2015], [Schmitt and Pfeifer 2015]. These tools are all simple instruments to systematize, visualise and structure a problem and examine causes and effects, counteractives and improvement measures.
However, there are few recommendations to use those tools to analyse the problem before the idea generating process. In common practice, a PA in this context is generally often shortened [Schlicksupp 1992], [Riedel and Schraps 2010]. One reason might be that it is not possible to measure precisely when the problem has been defined sufficiently. A method providing a sufficient status of PA using existing techniques as a preparation for the idea generation process is missing in the pertinent literature.

4. Initial results of a problem analysis process

In section 3, the state of the art was analysed and the main results were shown. In the following section, new concepts to support the processes of the FFE of the PD process are shown and the research questions from section 2 are answered.

4.1 Introduction of a problem analysis as an interface between search field analysis and idea management

The first research question (RQ 1, see Table 1) affects the need for a tool or method to refine the task for the idea generation process. In the following section, a concept of a PA is introduced to answer this question. This PA should be a necessary interface between search field analysis and idea management. As a consequence, a hypothesis can already be assumed: a structured PA as a preparation for the following idea process is necessary for generating a refined task and information background.
As shown in section 3, the interface between the search field analysis and the idea management is a field which has not been afforded much consideration in the literature. This interface should link the steps of the search field analysis and idea management. The main content is to analyse the problem itself, but to make sure that this is not the clarification of the task as it is known from PD like in VDI 2221 [1993]. The PA discussed in this paper defines the ideas by concretising the problem detected and examined in the search field analysis much more closely. As shown in Figure 2, the mentioned interface is part of the FFE (defined in Figure 1). Its structure was developed at the Institute for Engineering Design and Industrial Design (IKTD) of the University of Stuttgart.
This PA consists of two single steps. First is the problem determination in which the examined problem is determined and analysed. That means in detail that the problem is examined and context, object and effect of the problem are discussed and specified. It is also possible that the problem has to be divided

into smaller sub items which have to be examined separated. This analysis leads into the second step, which includes the generating of problem ideas. In this synthesis, problem ideas are created by synthesising the conclusion of the analysis in the first step and concretising as well as detailing the problem in a problem idea profile (see section 4.2). This synthesis gives answers to necessary question detailing the problem. At the end, this means that problem ideas are defined, prepared and set out in writing (profile) for the idea management stage.
Initial internal analyses at the IKTD have shown that the defined problem idea can be used as a fundamental information base in the idea management stage, where solution ideas are generated according to the problem idea. However, it must be emphasised that the practical use of this claim needs to be evaluated further, especially in industrial applications. As derived from the pertinent literature – shown in section 3 – an idea always consists of a problem idea and at least one suitable solution idea. So, by using a defined problem idea as a starting point for the idea management, new solution ideas can be generated. This is done by collecting knowledge about solution ideas (search), the connected externalisation of that knowledge by the development (find) and the determination of concretised solution ideas (specify). The result is an accumulation of solution ideas which have to be evaluated in the next step. The most promising solution ideas have to be selected (see [Messerle et al. 2012]). However, it should be pointed out that idea management is not a general part of this paper.

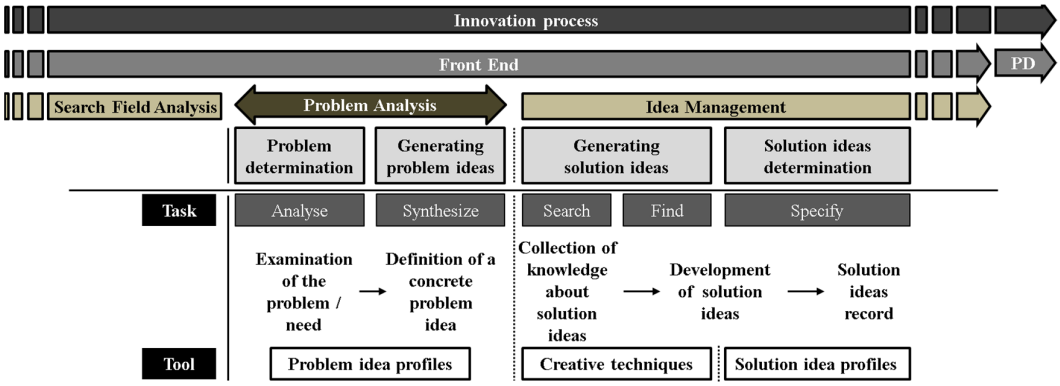

Figure 2. The problem analysis as an interface in the FFE of the innovation process

So, as shown in section 3, the PA is often rather undistinctive [Schlicksupp 1992], [Riedel and Schraps 2010]. To satisfy the wishes of the customer or to solve the problem or the company's issue, however, gaining a fundamental understanding is very important for the innovation's success [Khurana and Rosenthal 1997]. To have full information about the strategy, targets and significant indicators, a mature and clear task has to be given to the engineers dealing with the idea management phase for increasing the quality and efficiency as well as reducing time for additional clarifying loops. An example for the benefit might be the handling of the selection of a suitable creative technique. Knowing exactly what the target is, the selection of a creative technique can be supported according to the information found and clarified in the PA. However, this depends on the kind of problem concerned. If the problem is formed by a customer need which can be solved using an incremental innovation, the kind of creative technique can have a focus different to the one it would have if the company's management desired a radical innovation. Therefore, a further examination of this issue should show whether the PA can support the selection of a correct creative technique.
The necessity of the aforementioned PA has been discussed with two industrial experts cooperating with the IKTD. They emphasised the demand for a precise task to generate new solution ideas. This is emphasised by Abele [2013], who alleges that technical specification cannot be defined for new solution ideas because need specifications are missing. However, the process of developing a refined task has to be adapted to the respective company.

4.2 Main content of the introduced problem analysis

In the following section, the discussion on the content of the PA will be presented roughly by documenting several basic pieces of information. The reasons for this are the so far little adoption and

evaluation in industrial practice. The followed approaches are therefore primarily based on sources from literature. In order to find a suitable hypothesis, the target of the PA must first be defined. The information from the PA should help to achieve a refined task in order to generate solution ideas according to the targets of the company's strategy management. Simultaneously, the refined task should not limit the solution space. Besides, the information and data should reduce the need for coordination and enhance transparency. To give an answer to RQ 2, several questions (see Table 2) are discussed hereafter which have to be answered during the PA. So, the introduced PA is closely related to the 5-Why-method and forms a special checklist (both methods indicated in section 3).

Mencke [2012] introduces several advices which can support a PA. Some extracts are adopted and discussed to be a part of the introduced PA. Firstly, the question of what exactly the problem is should be clarified. Additionally, a PA should deal with its reasons and causes [Mencke 2012].

With answers to these questions, an initial insight and clarified description of the problem can be given. By knowing the causes and reasons for the problem, solution ideas can be precisely developed with regard to the origin of the problem. Furthermore, knowing the fact, why the problem exists, is important, e.g. if some environmental regulations affect a solution for a problem.

This should be followed by the questions concerning the structure of the problem. The question of what belongs to the problem must be answered. Marginal problems and sub-issues affecting the main problem should also not be disregarded. It must be proven whether the problem can be structured into main problems and sub-items. Then, it has to be determined which items must be edited first. A structured order should therefore be discussed [Mencke 2012].

This helps to structure and prioritise the problem itself as well as the sub-issues. Thus, the focus can be worked out and clarified. Additionally, the framework of the problem and the interface to peripheral issues can be determined. As a complement to the approaches of Mencke [2012], the negative effects of the problem should be considered and the need to solve the problem should be enhanced in this way. The disadvantages can act as an origin for a solution by eliminating these issues.

Not only the problem, but also the effects of a solution, should be considered in the PA. If there have been activities to solve the problem so far, these actions should be investigated as well. Involved countermeasures should be indicated to avoid a duplication of work.

Questions dealing directly with the problem have been discussed up to this point (see Table 2, left column). What follows is the discussion of several questions concerning the strategy of the company and the specifications, e.g. elaborated upon by the top management.

People involved in the generating process of solution ideas often do not gain insight into time and cost restrictions. This should be essential background knowledge to satisfy the company's strategy and to eliminate solution ideas which do not fit into those restrictions. The approximate development time and the costs specified by a maximum time are decisive and should also be known.

Furthermore, it is necessary to know about the targets and the effects a solution may and must have [Mencke 2012]. These might be financial, organisational and market effects, e.g. some quantified targets such as the number of pieces and target price etc. One additional important information is the innovation strategy. Knowing, whether the strategy proceeds according to an innovation leader or follower can provide information about the risk of an idea, or rather a strategy.

To summarise, the main content of a PA should include the answers to the questions in Table 2. The questions which are not marked with a literature source are based on the experiences derived from examination at the IKTD. These questions and the necessity of this data together with the mentioned approaches by Mencke [2012] have to be proven, adapted and evaluated in industrial practice. This paper should be regarded as an initial framework of a PA.

A big influence on the result of the PA is exerted by people who answer the questions contained in Table 2. As these are very different and concern various departments of a company, the PA should be performed by an interdisciplinary team. The team should have experiences in all sectors dealing with the problem and the company’s processes. Further, an innovation manager should moderate the PA to act as an interface person for the subsequent idea management. The PA should also be recognised as a tool which makes the idea management more transparent and understandable. By providing a analysed, conditioned and refined problem description, people involved in development know what the exact restrictions are. So misunderstandings will not occur if their ideas are rejected. All of this leads to

research question 3 (section 4.3). So, how the information learned in the answered question (see Table 2) are saved and passed on to the idea generation process is intended to answer here.

Table 2. Necessary questions that a problem analysis should answer

Dealing with the problem		Dealing with the strategy	
Description	What is the problem? [Mencke 2012] Why does this problem exist?	Time	How much time is allowed for the time-to-market period?
Origin	What are the reasons/causes for the problem? [Mencke 2012]	Costs	What is the cost framework for the product development?
Structure	What belongs to the problem? [Mencke 2012] What is the context/framework of the problem? [Mencke 2012]	Targets	What are the quantified targets of the new solution? [Mencke 2012]
Effects	What is the effect of the problem? [Mencke 2012] Which barriers have to be considered? What is the effect of a solution for the problem?	Effect	Which effects may a solution idea have? [Mencke 2012] (Finance, market, organisation)
Counter-measures	What has been done to solve the problem until now?	Strategy	What kind of innovation strategy is striven towards (innovation follower or innovation leader)?

4.3 Information carrier of the problem analysis

In addition to the process of the PA mentioned in sections 4.1 and 4.2, a formal, transparent information carrier should be installed where all compiled information is saved. Kim and Wilemon [2002] state that formal processes and tools in the FFE have lots of advantages.
The transportation of the information is not only limited to the innovation manager. He will only act as a person who can detail the information based on the information carrier. Generally, the information carrier should be self-explanatory. Thus, the innovation manager can be supported and relieved.
As a hypothesis to RQ 3, a problem idea profile can be used for transferring the information further to the following steps (see Figure 2). Idea profiles or data sheets are known in literature for solution ideas, which carry information about new solutions. There are arbitrary ones, for example the "product idea data sheet" according to Gerhards [2001] or the "product idea sheet" according to Brandenburg [2002]. Such idea sheets have been used successfully in industrial practice, e.g. they are part of the idea management introduced in three industrial partners of the IKTD.
Such idea sheets are discussed to also be the right medium for problem ideas. The shape and the configuration of a problem idea profile have to be worked out in future research work and is not part of this paper. The research work must be combined with the content of the PA (see section 4.2) which must be defined in order to save the information properly in a profile.

5. Summary and discussion

In the following section, the presented outcomes are discussed critically and constitute a conclusion as to whether or not the research questions have been answered. In this paper, the necessity of a PA as a process preceding the idea generation process has been presented and initial approaches have been introduced. RQ 1, which deals with the means of developing a refined task for supporting processes of generating new ideas, was discussed and examined. The analysis of the state of the art shows that there is a lack of a process of generating a refined and more precise task as a preparation for the idea generation process. Practical work at the IKTD confirmed that the task and problem definition need to be defined clearly. Therefore, a PA was introduced as a solution approach. This approach leads to RQ 2, which treats the answers to investigatory questions and information needed to actually be used as support for subsequent idea generation processes. Questions derived from the state of the art and supplemented by own experiences were given regarding the problem itself and the company's strategy. A valid evaluation in industrial practice is being worked on at the moment but does not form part of this paper. RQ 3 –

asking for a medium to store the information of the problem – is answered by the approach of using of a data sheet known from solution ideas which forms a problem idea profile. The use of this data sheet is in preparation for industrial practice in order to evaluate its need, advantage and success. A similar problem idea profile has already been implemented in one cooperating medium-sized company, but the correctness of the information content must be proven and coordinated in detail. The PA and specification in data sheet should not limit the number of solution ideas. Rather, it should support the creation of purposeful solution ideas according to the right targets.

6. Conclusion and outlook

Based on the results and their discussion, some conclusions can be drawn. The state of the art does not contain a specific process of a PA which is used as a preparation for creative techniques and the idea generation process. The requirement for a tool to improve communication within the FFE of the IP is not seen as imperative. However, it has been shown by literature sources that an analysis of the task is necessary and desired to close the knowledge gap between strategy planning and idea management in the FFE. The presented concept shows how a PA as a preparation for idea generation processes might look. It still needs to be worked out in detail and evaluated in industrial practice. A more detailed elaboration should be prepared in further research work in close collaboration with industrial requirements so that all the relevant aspects can be discussed in a comprehensive way. The presented paper should therefore deal as a basis discussing a broader literature context to enter that research field. The authors will continue their work even more detailed in this field in the future.

Additionally, the applicability, usefulness and the completeness have to be verified by means of further research and evaluations. This should answer the question if the method is the best possible one or if improvements are necessary. For executing an evaluation in industrial practice, a procedure for the implementation of PA in business practice must also be developed (best practice examples). The target must be that any employee involved should gain the same understanding of the PA and the need and use for it. The main reason for the implementation of a PA is to save time and costs because the solution ideas are intended to focus on the actual problem. Consequently, engineers dealing with the evaluation and selection of solution ideas should be supported. It must be examined whether the PA with the result of a clear task can also support the evaluation and selection of solution ideas.

Additionally, it must be proven in further research that the problem defined through PA can be used for other issues. For example, an innovation manager receives the information and data on the problem detailed and analysed in problem idea profiles. Here, he can perceive the issue more easily and thus more easily communicate the main points of the problem.

Moreover, future research questions should deal with possible support of the evaluation and prioritisation of problem ideas by using problem idea profiles. Furthermore, a storage system of problem idea profiles might be developed to store problem ideas which cannot be edited immediately, e.g. because of a lack of resources, policy restrictions or technology problems. A storage system can also be used for marketing and strategy issues in order to develop or adjust their strategy according to the stored problems and needs. The requirement for a storage system for problem ideas and the way it might look should therefore be examined in further research work.

As the main contribution of this paper consists of the theoretical presentation of the PA tool, a demonstration of the practical use and benefit is still necessary. This comprises the actual research at the IKTD and will be presented in a future paper.

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