Are Real-World Requirements Supported by Current Innovation Management Systems? A Reality Check

Michael Fellmann
University of Rostock
Institute of Computer Science
Rostock, Germany
michael.fellmann@uni-rostock.de

Michael Poppe
University of Rostock
Institute of Computer Science
Rostock, Germany
michael.poppe@uni-rostock.de

Henning Hummert
University of Rostock
Department of Business Administration
Rostock, Germany
henning.hummert@uni-rostock.de

Bernd Marcus
University of Rostock
Department of Business Administration
Rostock, Germany
bernd.marcus@uni-rostock.de

***Abstract*—Managing suggestions for product and process improvements or other ideas from employees, which could result in new innovations, is one of the key factors to stay competitive in fast changing economic and technical conditions. For this reason, various innovation management systems (IMS) have been developed in recent years to help collect and structure ideas and finally to become more innovative. However, studies reveal that many small and medium-sized enterprises (SME) in particular have only little focus on innovation. This raises the question why they cannot benefit from the above-mentioned advantages of IMS and whether the actual needs of a company differ from the functions offered by IMS. Therefore, this work focusses on answering the question if state-of-the-art IMS meet existing requirements of enterprises. Empirical studies consisting of interviews, questionnaires, and workshops with employees from all departments of two companies provided insights into the requirements for innovation management (IM) and the success factors of implementing an IT solution for IM. These requirements are finally compared to features of current IT-supported IMS.**

Keywords—Innovation, Innovation Management, Innovation Management System, Empirical Studies.

I. INTRODUCTION AND MOTIVATION

During globalization, the development of technical advances is constantly accelerating, also thanks to Industry 4.0. An important aspect for organizations is the continuous improvement of their processes. However, when the potentials of digitalization have been largely exhausted, those responsible must enable optimization in other ways in order to set themselves apart from their competitors. [26] An important pillar of progress is found in innovation management, which is examined in more detail in this paper as a bottom-up driven system.

Due to rapidly changing markets, technical developments, increasing knowledge intensification and constantly changing customer requirements, companies are forced to create new products and services or update existing ones. This implies to constantly rethink and, if necessary, adapt their processes in order to satisfy customer needs [11]. Dynamic markets, shorter product life cycles and increased technological complexity make the topic of innovation management more urgent and topical than ever before. Such improvement and innovation activities are mainly done in larger companies which have their own Research & Development (R&D) departments. In contrast to this, small and medium-sized enterprises lack engagement in innovation processes [17]. Since 99,3% of the existing enterprises in Germany, which is a total of over 2 million, belong to the group of SMEs there might be great but unused potential for innovation [20]. In small companies, systems for managing innovation often do not play a role because management feels overwhelmed by them [16, 17]. Medium-sized companies have been considered most frequently in the literature. Many mid-sized companies do not exploit their innovation potential despite existing opportunities [21]. This underscores the importance of such an investigation in such companies. Larger companies, on the other hand, usually have sufficient capacity or a department for research and development.

In general, managing innovations is quite a challenge due to manifold stakeholders, high complexity and uncertainty and opaqueness of the processes [2]. In the literature, there have been a lot of different uncertainties in innovation processes identified. They may hinder SMEs from pushing creative ideas forward and in addition they are connected with financial risks [15]. Some of these challenges have already been addressed by current idea or innovation management systems (IMS) [24]. These software platforms typically are accessible from different kind of devices like personal computers (PC), smartphones or tablets and deliver a lot of functionality such as customizable workflows, rights and role management, comment and rating options, transparent processes and more [8]. However, IMS and innovation processes are often developed and implemented in a top-down manner. Participatory approaches, in which employees contribute to the requirements elicitation and later design and development of IMS are still rarely discussed and under-researched. This is the case even though it is widely acknowledged that employees are an indispensable source of new ideas due to their deep knowledge of the products, processes and customer needs [10]. More specifically, up to now

it is unclear what the effect of involving employees in the requirement elicitation process for IMS could be in practice. In addition, it is unclear whether this participative approach of designing participation would lead to different required requirements than those that are implemented by current IMS. Hence against this background, we ask the question "Are Real-World Requirements Supported by Current Innovation Management Systems?"

In order to explore and finally answer this question, in a first step we conducted an inductive and participative elicitation of innovation management phases as well as long-term success factors. Data collection was performed in an interdisciplinary study, consisting of a research team from business information systems and organizational psychology, conducted in two SMEs. Two very different companies (a medium-sized SME in the production of capital goods and a small SME in the field of consulting and digital technologies) were deliberately selected. The present study is a mixed empirical-quantitative and also qualitative investigation in order to obtain the most comprehensive data possible. To gather this information, a multi-method research design was used, integrating qualitative (i.e. interviews and workshops with representative focus groups) and quantitative (i.e. surveys targeting all employees) research methods. Due to the complex research question and the intended interactive bottom-up approach, we chose workshops as the starting point for the formulation of possible success factors, in order to then measure these in the form of a questionnaire using validated scales addressing all employees. Our main objectives were the elicitation of innovation management phases and decisions (cf. Section 2) and the identification of adequate and measurable success factors (cf. Section 3).

In a second step, requirements for an IT-supported IMS are derived from these empirical findings (cf. Section 4), which will moreover be compared with the characteristics of state-of-the-art IMS (cf. Section 5) in order to answer our research question.

In summary, our contribution lies in a critical assessment of state-of-the-art tools with respect to real-world requirements regarding innovation management phases and long-term success factors. With this, we are able to draw conclusions regarding the selection of idea management systems and identify further research opportunities. This paper will primarily focus on presenting the workshops and its results, the interviews and the evaluation of the survey will be presented in a cursorily form.

II. Workshop-based Elicitation of Innovation Management Phases and Decisions

A. Preparation and Execution of Workshops

While there are various innovation models mentioned and discussed in literature, these models seem to be very generic and have to be adjusted when implementing them into an IT-supported innovation management system [9]. Additionally, especially in service-oriented enterprises there are under-researched adoption barriers of existing formalized innovation processes which hinder their usage in practice [22]. The participation of as many employees as possible which submit their ideas and contribute comments and rate others' ideas is especially important for long-term success of participatory innovation management [4]. This is in contrast to the frequent top-down implementation of such systems that neglect participation [18]. In order to increase the level of participation, we conducted workshops in both manufacturing and service-oriented enterprises with participants from all enterprise departments to gain insights into how the employees want the process to look like and what are possible key factors of a successful implementation of an innovation management system.

Regarding the characteristics of the companies involved in data collection, one company is a metal processing / manufacturing company focusing on the production of lifting and pushing gearboxes. More than 100 people are employed there. The other is a company in the IT sector with about 35 employees. They offer various IT-services, from software development to consulting. Both companies had already been using IMS but the activities in these systems steadily decreased until they were finally not used at all anymore. For this reason, the statements and information collected directly from the employees that should work with such an IMS are important. They provide insights into what is highly relevant for the long-term implementation of an IMS. The workshop in the manufacturing company was attended by 10 employees, 3 females and 7 males, of all age groups. They work in the departments production (2x), assembly (2x), design (1x), sales (4x), and IT (1x). Seven employees attended the workshop in the service-oriented IT-company. Among them 3 females and 4 males in the age range of 30-60 years. Their departments have been human resources (1x), in-house management (1x), IT (2x), sales (2x), and management (1x).

Both workshops followed the same procedure. After a short introduction to the topic of innovation management, a definition of the term "idea" was jointly elaborated. This helped the participants to become familiar with the topic and to be prepared for the following tasks. Afterwards, they were asked to think about different activities that have to be done in the course of the process of innovation management. This process from the very beginning of having an idea in mind to the possible implementation of new processes or products. The participants were given some time while they should write their own thoughts on paper cards which they were then asked to present and explain. They also were asked to pin the paper cards on a wall in a chronological order. With little moderation and support by the moderators of the workshop, the participants were able to find clusters of activities by themselves and pin their written activities to already existing clusters. Finally, seven different activity phases could be identified (see Section 2.2) which also can be seen as process phases.

With the wall filled with different activities, we then collaboratively elaborated responsibilities for individual activities and process steps. This group discussion was a welcome change from the elaboration of the process phases. The reflection on responsibilities helped the participants to subsequently think about possible data elements that must be available when moving from one process phase to the next. The data elements, again written on paper cards, were again presented individually, commented on, and attached to the process phase in which they were needed. During this collection and presentation of data elements, some statements have already been made regarding their usefulness for later decisions in the

process of innovation management. This facilitated the transition to the next task, in which a simple process model resembling a sequence of activities with various decisions was to be developed together. Having done this in both enterprises, we were able to identify similarities and finally consolidate phases.

B. *Consolidated Phases*

The process phases in both enterprises were similar. In detail, we identified the seven abstract chronological process phases Idea Generation, Discussion and Specification, Rating, Feasibility Study, Design, Implementation and Result Evaluation (cf. Fig. 1).

Fig. 1. Participative elaborated and consolidated process phases for innovation management

During the idea generation process, employees think about identified potential for improvement, from which ideas for new or modified products or processes can emerge, that are then entered into an innovation management system. Subsequently, the submitted ideas are discussed in groups or even by all employees, which either leads to concretization or show an early non-feasibility. For this purpose, the participants suggested commentary mechanisms, as they already know them from major social media platforms. They also mentioned that there need to be a variety of data elements that have to be filled, e.g. benefit of the idea, possible risks or affected departments. The ideas that passed the discussion phase, can then be evaluated by all employees in the rating phase. In this context, the participants tended to a simple voting mechanism, with two options (e.g. like or dislike) rather than five options (e.g. stars). Having been rated, sorting the ideas according to their rating results offers on the one hand a prioritization, on the other hand it is also possible to reject all ideas below a certain rating score or to define another decision point. During the following feasibility check phase, the idea is further developed and checked in more detail for feasibility in terms of available resources and markets. If the idea is promising and the realization is possible, an implementation plan including a prototype should be created within the design phase. This is the prerequisite for the following implementation phase, in which the idea is realized. Finally, the completed implementation must be evaluated, whereby the idea provider, the implementers and other parties involved check whether the desired goals have been achieved.

In general, the participants agreed that for each phase it must be determined which person or group is responsible for the ideas, so that no idea remains untouched. This led to the conclusion that there need to be a role and authorization concept. Furthermore, there can be a varying number of decisions whether to continue working on the idea or to reject and archive it. The results of the workshops showed that it must be individually defined when and according to which criteria it should be decided whether an idea should be further developed or rejected. However, both companies agreed that the first decision should be made after discussion and specification. Also, time played a role since repeatedly participants emphasized that there should be a time-out for most of the phases in order to prevent ideas from getting stuck in the process.

In comparison to innovation management models already presented in the literature, we found numerous similarities to our process described above. COOPER presented a stage-gate-model in 1990 which consists of five stages (process phases) and gates (decisions) [3]. The number of different stages and gates varies in later adoptions of this model due to combining of activities or formulating them more detailed. However, most of them have an initial screening, modelling of business cases, development, testing and the stage of market launch in common. Since the focus of our workshop was to elaborate a process for innovations as well as smaller improvements of process flows, market launch or even distribution of products were not in the mind of the participants. Unlike our process elicited in the workshop, COOPER defines a decision between each phase. The participants were explicitly against too many decisions. Other models like the innovation life cycle model from WESTERSKI et al. also consist of the phases Idea generation, Idea improvement, Idea selection, Idea implementation, and Idea deployment [25]. However, in contrast to our process, there is no decision described at all in this life cycle model. The description of an innovation process flow by THOM contains three main phases (Idea generation, Idea acceptance, and Idea realization) with three different activities for each [23]. Since there are two decisions in this process, the number of phases is identical compared to our findings. However, some phases such as the feasibility study are not explicitly mentioned by THOM, but these activities can be assigned to other phases. These examples illustrate that the participants of the workshops intuitively conceptualize an innovation process in a way that is already mentioned in very similar forms in the literature.

However, some of the participants in the workshops noted that of the phases developed, the first three should be part of an idea management. The last four process phases, on the other hand, can be seen as part of project management systems already in use in both of the companies.

The knowledge gained about the process and its different activities from the idea to the possible implementation as well as the necessary data, together with the empirical studies of success factors of an innovation management system are subsequently used to derive requirements for such a system (cf. Section 4).

The research is funded by the Federal Ministry of Education and Research of Germany and the European Social Fund within the framework of the program "Future of Work" (project number 02L17C610).

III. Long-term Innovation Management Success Factors

A. Elicitation from Interviews

Using qualitative face-to-face interviews as a research method in the context of a field study has several advantages, especially at an early stage in the research process [27]. Firstly, explorative insights into a new area can be gained. Secondly, the researcher has the opportunity to create a comfortable and friendly interview setting. As a consequence, participants tend to express their personal opinions and experiences more openly and, in more detail, compared to a written questionnaire. Moreover, the interviewer can interject where necessary to ensure that the interviewee understands the questions as well as he or she understands the answers. This is especially important when subjects are interviewed who are expected to be nervous and/or might having difficulties in comprehension.

Based on an analysis of literature and prior expertise, a semi-structured interview guide was constructed. It contained questions covering the organization's innovation culture in general, the existing innovation management process, and the individuum's innovation generation history. In addition, several questions in regard to wishes for a future innovation management process and about possible success factors were asked.

Two researchers from both disciplines (business information systems and organizational psychology) conducted 23 interviews with current employees. Out of them, 16 work in the metal processing / manufacturing company mentioned in Section 2.1 and 7 at the IT company. Participants were carefully selected to cover all company departments (e.g. sales, technical design, manufacturing, finance, field service) and all hierarchical levels, up to both managing directors. For each department at least two employees were questioned. To ensure a maximum amount of anonymity, no demographical information besides the department was recorded. Duration of the interviews was on average about one hour. Key statements for each interview were transcribed and summarized in order to serve as a starting point and foundation for the workshops (cf. Section 3.2) and the survey (cf. Section 3.3).

Interviewees saw potential with regard to innovation activities within their company and named a wide array of requirements for a future innovation management system (e.g. transparency, ease-of-use). They also emphasized the high priority of qualified feedback and lively internal communication across departmental boundaries. The same applies to organizational climate, work motivation and job satisfaction. The interviewees often attributed the continuous decrease in activities with previously used IMS to a lack of feedback and appreciation.

B. Elicitation from Workshops

After collecting the participants' thoughts about their wishes and expectations of an IMS, as described in Section 2, the employees participating in the workshops were finally asked to think about possible factors that make an IMS in a company successful in the long term. In this way, all of the participants had already been thinking about possible designs and implementations of IT-supported IMS and could rethink about the previous workshop hours for their final conclusions about what is needed so that the IMS is used persistently and ideas are continuously submitted, processed and possibly realized.

In order to allow the workshop participants to think for themselves, they were given some time to independently write their personal success factors on paper cards. While doing so, they should not only think about factors that are relevant to themselves to use the IMS in the long term, but also about factors that they think are necessary for everyone to use the system in the long term. Everyone was asked to present and comment on their own thoughts to avoid misunderstandings. Afterwards, the individual success factors were pinned on the wall so everyone could see them. During this process it was observed that the participants already intuitively hung their described cards close to similar success factors already mentioned and pinned. This enabled the moderator to easily cluster the success factors after all presentations in a manner that all participants agreed with. As an exemplary result from the manufacturing company, the four categories *IT-platform*, *integration of innovation management into daily business*, *process-related factors* and *motivation* could be identified. Having found these main success factor categories, the participants were asked to prioritize them as a final step. Therefore, each person received 3 green dot stickers, which could be placed on a category that the respective person considered important. The points could be distributed freely, so that all three points could also be stuck to a single category if it was considered extremely relevant. Based on the assignment of the dots (cf. Fig. 2) it turned out, that the most important factor appears to be *motivation*.

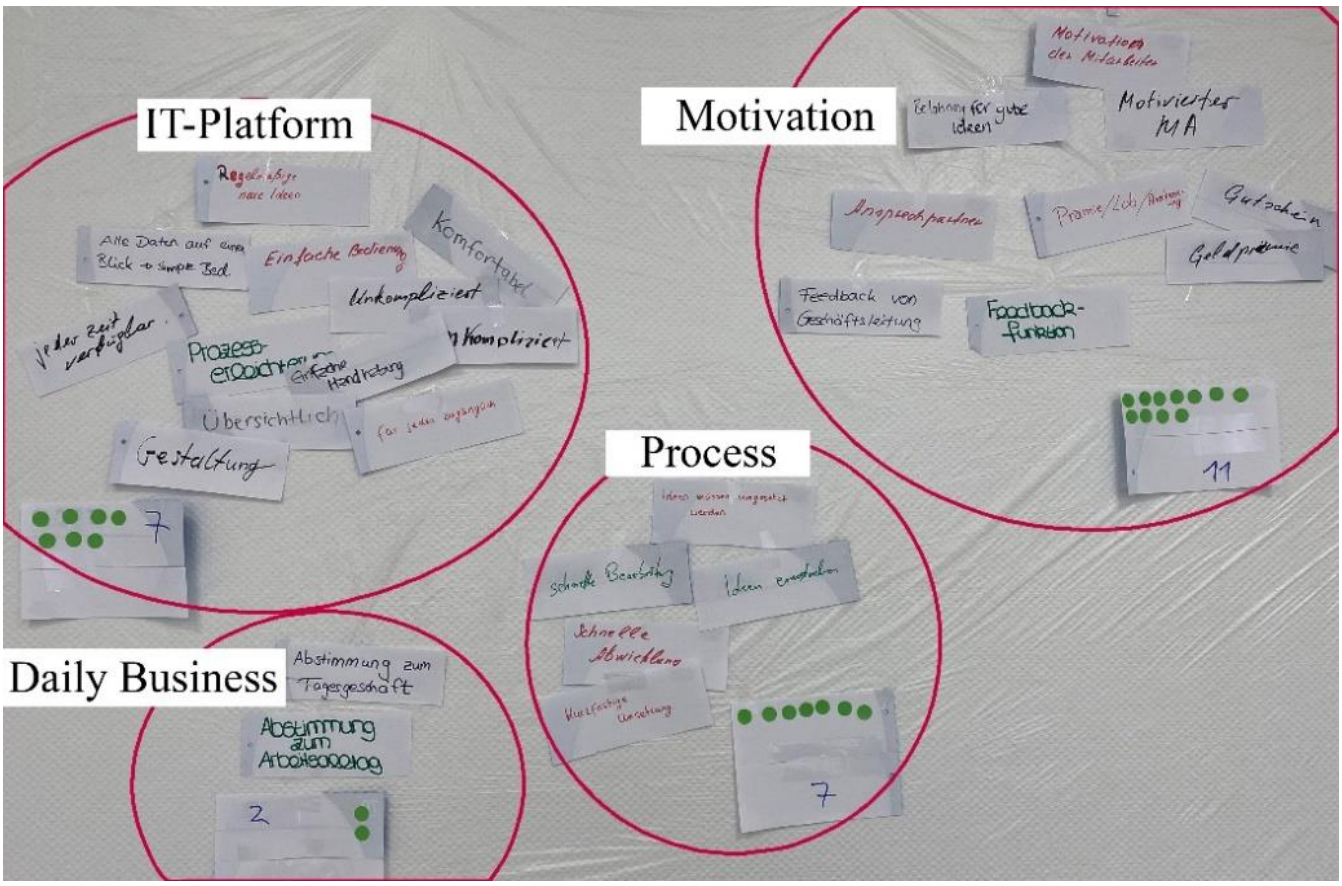

Fig. 2. Success Factors of IMS gathered by Workshop

However, due to the non-anonymous allocation of points within the workshop group, there is no further classification of which kind of motivation is more relevant: extrinsic or intrinsic. The result was quite similar for the IT service provider, but some additional success factors were also identified, for example in the area of corporate culture or implementation of the IMS. Moreover, there was a large consensus among the participants *that there must be a "caretaker" of the IMS* whose job it is to keep the system alive and motivates the colleagues to think about improvement potentials which could be submitted into the system. The factor that was given noticeably high priority in both workshops was *feedback and appreciation*, especially in terms of equal consideration of all ideas.

C. Elicitation from a Survey

As a result of the interviews and the workshops, several quantifiable success factors (in the sense of key performance indicators) were identified in order to assess the effect of introducing a new innovation management. Constructs covered were Organizational Identification [28], Innovation Climate [29], Overall job satisfaction and Satisfaction with inter-departmental cooperation. Based on established and published questionnaires a baseline survey was constructed, addressed at all employees.

To take account of the specificities of both companies, a paper-and-pencil version (metal manufacturing) and an online version (IT-services) were used. The response rate was very good, with more than 50% of the respective workforces (N1 = 57, N2 = 18) returning a completely filled out questionnaire. Again, no demographic data was recorded to assure anonymity.

At this point in time we would like to refrain from presenting specific results, since it can only be correctly assessed by comparing it to a latter re-sampling.

In addition to these questions from the organizational psychology, business information systems related questions were asked about how relevant different features of an IMS are. The clearest result delivers an average of 4.6 on the statement "Feedback is important." (where 4 means "agree" and 5 means "totally agree") which underlines the importance of the success factor feedback for an idea provider.

D. Consolidated Success Factors

After the empirical investigations and surveys, researchers from the interdisciplinary research team of business information systems and organizational psychology aggregated the gathered information. Four different success factor categories could be identified to which the aggregated success factors belong to: IT-Platform, Process, Company and Motivation. The success factors for the categories and the measures, which were identified from the investigations to achieve these success factors, are shown in Table 1.

TABLE I. CONSOLIDATED SUCCESS FACTORS

Category	*Success Factor*	*Measure*
IT-Platform	User-friendly design	- All data at a glance - Simple handling - Comfortable - Uncomplicated - Clearly structured
	Accessibility	- Accessible to everyone - Available at any time - Cross-platform
Process	Idea submission	- Simple, fast, uncomplicated - Multi-channel - It must be possible to submit spontaneous ideas directly - Possibility for anonymous submission
	Processing of ideas	- Taking ideas seriously - Equal consideration of all ideas - Ideas must be implemented - Fast handling and processing
	Transparency	- Decisions must be objective and comprehensible - Processing status visible at any time
Company	Business culture	- Culture for consideration of employee suggestions must exist - Management commitment
	Integration of an IMS	- Training when introducing a new tool - Coordination of the use of innovation management with daily business
Motivation	Communication	- Contact-person - Feedback - Announcement after implementation of the platform
	Incentives	- Blog for implemented innovation - Reward for good ideas - Awards / praise / recognition

Almost all success factors identified by GERLACH and BREM in an extensive literature research concerning idea management [8] can also be found in our elaborated success factor list. Since they conducted a research without the focus on IT-supported IMS, factors related to IT platforms are missing there. Thus, the results of our interviews, survey and workshops confirm the findings from the literature and vice versa.

IV. DERIVATION OF REQUIREMENTS FROM THE CONSOLIDATED PROCESS AND SUCCESS FACTORS

The consolidation of process phases (see Section 2) and the gathered success factors (see Section 3) imply many requirements that an IT-supported IMS must be able to fulfil and which are derived below.

Derivation from process phases. According to the elaborated process it is necessary that an IMS offers different ways and support for submitting ideas. Due to possible obstacles caused by weaker writing skills, there must be other possibilities instead of writing on one's own, such as submitting by voice or via a separate idea submitter. This is just one example for the necessity of a rights and role management. This should be possible not only at the workplace, but also at home when an idea comes to somebody's mind. Many participants would appreciate to being able to submit ideas anonymously if there might be a risk that it could disappoint their supervisor. It is also necessary that there are customizable form fields and idea attributes to enter information on risk, chances, estimated time for realization and so on. To be able to discuss the ideas within the system, it needs comment and editing functionalities. The majority of the participants wants to rate and prioritize ideas. Therefore, there needs to be a rating mechanism. Since participants agreed that the last 4 phases should be handed over and executed in separate project management tools, but information like current status should still be seen inside the IMS, there could be an interface to the project management. However, this was not called as an essential requirement since the status and updates can also be entered manually by a responsible person. Due to slight differences in the concrete conception of later processes in both companies, the workflow must be adjustable to some extent.

Derivation of additional requirements from success factors. Since one of the most called success factor is related to usability, user-friendly design seems definitely to be a requirement whose absence could contribute to non-use of the system. Motivation was another often-mentioned success factor, which could be achieved by recognizing the idea provider through compliments or rewards. Therefore, automated but also personal feedback functionalities are necessary, as well as possibilities to calculate rewards and give awards. Some participants also mentioned that they would be motivated if there would be a blog which presents successful implemented ideas in their company but also success stories from other companies. In addition, motivation could also be achieved by meeting the requirements of a fully transparent process in which employees can always track the status of their idea and understand how decisions have been made. To ensure that the ideas are processed and not forgotten, there must be reminder functions.

A collection of these described requirements, divided into functional and non-functional requirements, is presented in alphabetical order in Table 2. Functional requirements specify which functionality or which behaviour the software product should have or fulfil under specified conditions. Non-functional requirements, also called technical requirements, describe aspects that typically affect or overlap several or all functional requirements (cross-cut). They usually have an influence on the entire software architecture. Furthermore, non-functional requirements influence each other. [1, S.109]

TABLE II. FUNCTIONAL AND NON-FUNCTIONAL REQUIREMENTS

Functional Requirements	*Non-Functional Requirements*
- Blog / News - Calculate rewards / give awards - Choice of anonymous submission - Comment function - Customizable form fields - Customizable workflow - Definition of responsibilities - Event-driven feedback - Rating system - Reminder functions - Rights and role system - Submission of ideas in different ways - Tracking of own ideas	- Accessibility at any time and from anywhere - Integration into daily business - Platform independence - Transparency of the process - User-friendly design

A. *Reference to knowledge management*

The Institute for Knowledge-Based Organizations (IBM), in collaboration with leading corporations and government organizations, has outlined challenges that often arise when implementing knowledge management systems [7]:

- Insufficient alignment with corporate strategy
- Knowledge capture without management needs assessment
- Failure to implement in employees' daily work lives
- Too much focus on formal learning efforts as a mechanism for knowledge sharing
- Focus only on internal organizational view

The points listed are not exhaustive, but can help the organization target their knowledge, reduce costs, and increase customer satisfaction. Lin and Tseng [24], in a literature review, summarized the success factors for knowledge management systems, as follows:

- Identification of what type of knowledge is relevant.
- pursued goals must be communicated and justified in order to achieve a common understanding within the company
- Dealing with acquired knowledge
- The generation of new knowledge concerns all employees, which must be clearly communicated

Knowledge management shows us how to deal with new impulses from employees and how to process and use knowledge gained in the course of innovation management. If the success factors of innovation management are supplemented with the insights gained from knowledge management, the result is a holistic, sustainable approach that can drive innovation forward. (For more in-depth research we recommend [6].)

V. Matching Key Requirements to Current Tool Features

A. *Overview on State-of-the-Art Idea and Innovation Management Tools*

In order to compare the requirements derived in Section 4 with IT-based IMS, we searched the literature for tools already mentioned and also looked for other tools already used by larger companies. As a consequence, the following 5 different tools were selected.

CrowdWorx. Within the CrowdWorx® Innovation Engine™ various innovation activities, e.g. idea and innovation management, continuous improvement, crowd sourced innovation and open innovation can be conducted in one single platform. The platform independent CrowdWorx® Innovation Engine™ is used for example by Continental, VW, Telekom, and Deutsche Bahn [5].

Innolytics. The German Innolytics GmbH offers various, highly customizable software products like innovation management, knowledge management, continuous improvement and collaboration software [13]. Innolytics' references are for example Nestlé, Vodafone, and GlaxoSmithKline.

ITONICS. The modular software suite ITONICS enables companies to manage their innovation strategy from trend scouting and idea management to innovation portfolio management and road mapping [14]. Customers of ITONICS are Audi, BMW, INTEL, and many more.

HYPE Innovation. Another collaborative idea and innovation management system is provided by HYPE. Like the tools already mentioned HYPE offers a broad range of functions, e.g. supporting the ideation process with idea campaigns, idea management, evaluation methods and portfolio management. It is also platform independent, just as all other tools are. Some selected clients are NASA, AIRBUS, Boeing, and Bosch [12].

Qmarkets. The IMS Qmarkets also provides support for internal and external idea generation and the management of resulting incremental or disruptive innovations. Qmarkets does also has a lot of well-known customers like Ford, Lufthansa and Schindler [19].

Since all the selected tools are designed for innovation management, which is a long-established management area, they differ only slightly in their core functionalities. Larger differences can be found in the analysis of submitted and completed ideas and innovations (e.g. portfolio analysis methods), as well as in the forecasting of possible future trends (e.g. trend scouting). How these tools meet the requirements expressed by the employees is the subject of the next section.

B. *Requirements and Tool Feature Matching*

Since the vendors of the selected tools do not provide a separate list of specifications that describes all features of their products, the product web sites, marketing videos and other reports were searched for information on the features described in Table 2. As a result, Table 3 compares the collected requirements with the number of tools that support them.

TABLE IV. MATCHING OF REQUIREMENTS AND TOOL FEATURES

Requirement	*Supported by # of tools*	*Comment*
Blog / News	5	Home screens or separate sections can be designed where news can be presented.
Calculate rewards / give awards	5	To keep employees motivated, gamification elements or functions to calculate possible rewards for different ideas can be used.
Choice of anonymously submission	2	Two providers explicitly mention the function to submit ideas anonymously.
Comment function	5	Comments can be added to ideas, making discussions possible.
Customizable form fields	5	Forms within the innovation management process are customizable so that individual enterprise requirements can be fulfilled.
Customizable workflow	5	Workflows can be adjusted to individual requirements. It is also possible to define different workflows for different idea categories or sources.
Definition of responsibilities	5	Responsibilities can be defined and set at various process stages of ideas and for each idea separately. This way, for example experts can be set as responsible when reviews or decisions have to be made.
Event-driven feedback	5	Feedback can be given via E-Mail. The tools provide automated feedback when the status changes or at other defined events within the workflow. It can be personalized through individual messages from responsible persons.
Rating system	5	There are numerous rating systems offered within these tools like pairwise-voting, token-voting, rating with 5 stars to assign or thumbs up and down.
Reminder functions	5	To prevent forgetting ideas, responsible persons can be reminded after pre-defined periods of time.
Rights and role system	5	Different actors such as employees, supervisors, managers or even customers with access to an IMS must be able to be assigned different permissions depending on status, idea category or other factors
Submission of ideas in different ways (also in terms of accessibility)	5	The selected tools are cross-platform tools so that ideas can be submitted via business PC or via mobile device from home. Some tools also offer functionalities to submit ideas via mail and with audio or video recordings.
Tracking of own ideas	5	Within all of these tools, user can track their submitted ideas (including current status) in a separate list.
User-friendly design	5	High customization provides great flexibility in terms of different views or individual form fields.
Transparency of the process	5	Transparency is also achieved through the traceability of own ideas and possibilities to design transparent processes

The table indicates that almost all requirements gathered from the employees are met by all of these tools. Just the functionality of possible anonymous submissions is mentioned by only two of them. However, this does not necessarily mean that the other 3 IMS do not support this functionality. It could also be possible that they do not explicitly emphasize it on their presentations and thus do not consider it to be of great importance.

VI. CONCLUSION AND OUTLOOK

With this study, we gained insights by direct involvement of employees of two companies. We found that employees of two companies perceive an innovation management process in a very similar way than it is suggested in literature, such as the stage-gate model [30] or the Graz innovation model [31]. Thus, our contribution to the academic knowledge base lies in confirming the developed models that have been suggested in literature by underpinning them with empirical data. A limitation is that we only captured in two industries: manufacturing and IT-services. Based on the success factors named by the employees, it can also be confirmed by empirical insights that the success factors mentioned in the literature are up-to-date and relevant. This is a relevant contribution to academic knowledge, since innovation processes are often developed in a rather top-down manner involving stakeholders of the management. In contrast to this, we conducted workshops with the employees to elicit their preferences and needs inductively in a bottom-up manner. The requirements derived from these investigations are completely fulfilled by almost all of the selected IMS, which offer much more functionality than the participants imagined or wanted. The fact that current IMS tools seem to support employee participation can be explained by the fact that the focus of this study was to determine the requirements of the employees who should fill the system with ideas and knowledge. However, managers who want to evaluate the value of an IMS may have additional requirements for the functionality of such a system, which may include portfolio management, for example.

In addition, we found that all systems offer many options for valuing employee participation within an IMS, for example in the form of automatic and personal feedback, support in bonus calculations or gamification elements such as the awarding of medals after achieving specific goals.

In summary, at least at a first glance, all conditions for successful IT-support of innovation management should be fulfilled. However, some of the success factors that emerged in our empirical investigation cannot be directly transferred to the requirements of a software platform, such as corporate climate, management commitment, accessible contact persons, or integration into the daily work routine, are also very relevant for the success of innovation management. The extent to which the tools can facilitate the fulfilment of these factors would need further research. The take-home message of the paper is that the systems currently on the market meet the basic technical requirements, but that other aspects of knowledge management must also be considered. In order to successfully operate a bottom-up driven innovation management system, a holistic approach must be taken that includes the needs of the employees, identifies relevant topics, clearly highlights goals, moves topics forward in a structured manner, and encompasses all of its employees.

In the future, it will be the researchers' ambition to study more companies from different industries with different framework conditions. Since the IMS offers so many different functions that are not even demanded by the employees, another interesting research question could answer which functions managers and employees actually use and how much influence these functions have on the successful use of such a system. Furthermore, future research could focus on the identification of system features that were not initially desired by managers or employees (or both) but that later turned out to have a positive impact on the transformation process of ideas into successful innovations. In other words, while we now have evidence that current tools are capable to meet explicit requirements from employees, it may be worthwhile to investigate their hidden impact on innovation and to identify still untapped opportunities to foster innovation. This seems to be highly relevant, since despite existing IMS, many companies still lack sufficient innovation activities which are however crucial for long-term survival in ever changing markets.

ACKNOWLEDGEMENT

The research and development project PANIWO, on which this report is based, is funded by the Federal Ministry of Education and Research of Germany and the European Social Fund within the framework of the program "Future of Work" (project number 02L17C610) and is supervised by the Project Management Agency Karlsruhe. The responsibility for the content of this publication lies with the authors.

REFERENCES

[1] Balzert H. (2011) Nichtfunktionale Anforderungen. In: Lehrbuch der Softwaretechnik: Entwurf, Implementierung, Installation und Betrieb. Spektrum Akademischer Verlag. https://doi.org/10.1007/978-3-8274-2246-0_9

[2] Bouwer, L.: Capabilities-Driven Innovation Management Framework: Crossing the Innovator's Chasm. Unpublished, 2015.

[3] Cooper, R. G.: Stage-gate systems: A new tool for managing new products. In Business Horizons, 1990, 33; pp. 44–54.

[4] Castiaux, A.; Paque, S.: Participative innovation: when innovation becomes everyone's business. In International Journal of Entrepreneurship and Innovation Management, 2009, 10; p. 111.

[5] CrowdWorx: CrowdWorx Innovation Engine. https://www.crowdworx.com/en/, accessed 14 May 2020.

[6] Michael Fellmann, Benjamin Nast, Jannik Knoblich, Marcus Triller, Michael Poppe, Henning Hummert and Bernd Marcus. 2021. Zur Einführung von Innovations- und Ideenmanagementwerkzeugen in Unternehmen. In Proceedings of ACM Ingolstadt conference (INGOLSTADT'21). ACM, New York, NY, USA, 7 pages. https://doi.org/10.18420/muc2021-mci-ws04-426

[7] Fontaine, Michael und Eric Lesser: Challenges in managing organizational knowledge. IBM Institute For Knowledge-Based Organization Publication, 2002.

[8] Gerlach, S.; Brem, A.: Idea management revisited: A review of the literature and guide for implementation. In International Journal of Innovation Studies, 2017, 1; pp. 144–161.

[9] Hernandez-Munoz, L. et al.: A state-of-the-art analysis of innovation models and innovation software tools. In (Dameri, R. P.; Garelli, R.; Resta, M. Eds.): Proceedings of the 10th European Conference on Innovation and Entrepreneurship. ECIE 2015 The University of Genoa, Italy, 17-18 September 2015. Academic Conferences and Publishing International Limited, Reading, UK, 2015; pp. 237–245.

[10] Høyrup, S.: Employee-driven innovation and workplace learning: basic concepts, approaches and themes. In Transfer: European Review of Labour and Research, 2010, 16; pp. 143–154.

[11] Hüsig, S.; Waldmannstetter, K.: Empirical analysis and classification of innovation management software. In International Journal of Product Development, 2013, 18; p. 134.

[12] HYPE: HYPE Innovation. https://www.hypeinnovation.com, accessed 14 May 2020.

[13] Innolytics: Innolytics Innovation. https://www.innolytics-innovation.com/, accessed 15 May 2020.

[14] Itonics: Itonics-Innovation. https://www.itonics-innovation.com/, accessed 14 May 2020.

[15] Jalonen, H.: The uncertainty of innovation: a systematic review of the literature. In Journal of Management Research, 2011, 4.

[16] Kohn, Stefan und Stefan Hüsig: Potential benefits, current supply, utilization and barriers to adoption: An exploratory study on German SMEs and innovation software. Technova-tion, 26(8):988–998, 2006.

[17] Pohl, P.; Kempermann, H.: Innovative Milieus. Die Innovationsfähigkeit deutscher Unternehmen. Bertelsmann Stiftung, 2019.

[18] Pereira, J.; Romero, F.: An innovation support system for SMEs: Proceedings of the European Conference on Innovation and Entrepreneurship, ECIE, Portugal, 2018; pp. 1015–1022.

[19] Qmarkets: Qmarkes. https://www.qmarkets.net/, accessed 15 May 2020.

[20] Rudnicka, J.: Kleine und mittlere Unternehmen (KMU) in Deutschland. https://de.statista.com/themen/4137/kleine-und-mittlere-unternehmen-kmu-in-deutschland/, accessed 7 May 2020.

[21] Rymaszewska, Anna Dorota: The challenges of lean manufac-turing imple-mentation in SMEs. Benchmarking: An Interna-tional Journal, 21(6):987–1002, 2014.

[22] Schultz, C. et al.: Application and performance impact of stage-gate systems - the role services in the firm's business focus. In R&D Management, 2019, 49; pp. 534–554.

[23] Thom, N.: Innovationsförderliche Ausrichtung von Führungsinstrumenten Grundbausteine und ihre Anpassung an die Unternehmensgrösse. In (Thom, N.; Zaugg, R. J. Eds.): Excellence durch Personal- und Organisationskompetenz. Verlag Paul Haupt, Bern, Stuttgart, Wien, 2001; pp. 319–341.

[24] Thom, N.: Idea Management in Switzerland and Germany: Past, Present and Future. In Die Unternehmung, 2015, 69; pp. 238–254

[25] Westerski, A.; Iglesias, C. A.; Nagle, T.: The road from community ideas to organisational innovation: a life cycle survey of idea management systems. In International Journal of Web Based Communities, 2011, 7; p. 493.

[26] Wissing, Tobias; Mit Green Lean Digital Factory zu nachhaltiger Produktion, 2020, https://www.capgemini.com/de-de/2020/10/produktion-nachhaltigkeit/. Abgerufen am 14.05.2021.

[27] Schröder, J. (2016). Face-to-Face Surveys. GESIS Survey Guidelines. Mannheim, Germany: GESIS - Leibniz Institute for the Social Sciences. doi: 10.15465/gesis-sg_en_005

[28] Martin R. Edwards & Riccardo Peccei (2007) Organizational identification: Development and testing of a conceptually grounded measure, European Journal of Work and Organizational Psychology, 16:1, 25-57, DOI: 10.1080/13594320601088195

[29] Kauffeld, S., Jonas, E., Grote, S., Frey, D. & Frieling, E. (2004). Innovationsklima - Konstruktion und erste psychometrische Überprüfung eines Messinstrumentes. Diagnostica, 50 (3), 153-164.

[30] Robert G. Cooper and Elko J. Kleinschmidt (2001): Stage-Gate® Process for new Product Success. In: Jens Arleth (Ed.) Innovation Management 2001. https://teaching.healthtech.dtu.dk/teaching/images/3/3c/Stage-gate.pdf

[31] Lercher, Hans, Big Picture - The Graz Innovation Model (May 1, 2017). Big Picture - The Graz Innovation Model, 2020 ISBN 978-3-902819-77-2, Available at SSRN: https://ssrn.com/abstract=2965373