Knowing is Silver, Listening is Gold: On the importance and impact of feedback in IT-based innovation contests

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ABSTRACT
IT-based innovation contests are making use of distributed knowledge of users and other external stakeholders to collect ideas or to let them develop innovations for new products and services. In addition, IT-based innovation contests increasingly offer functionalities to evaluate and comment the submissions of other participants. Whether this feedback proves to be useful to enhance the quality of submissions is examined in a field experiment. We use the theoretical perspective of absorptive capacity for a cluster analysis to identify relevance of feedback in form of comments, in comparison to relevance of participants' individual knowledge. The most important result indicates that listening to comments by other users can even overcome a lack of individual knowledge. The study strengthens first assumptions that the design element 'community functionality' needs to be carefully designed and implemented when setting up an IT-based innovation contest.

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Open innovation, innovation contest, community functionality, absorptive capacity, feedback

1. INTRODUCTION
In innovation and R&D management, external sources of knowledge and innovation have become increasingly relevant [57]. Opening the firm's boundaries to external inputs enables companies to realize new product and service innovations. Therefore, customers and external partners represent an important source of information for new product and service concepts. Their active integration in the innovation process is subsumed under the term 'open innovation'. By integrating external knowledge into a company's R&D, open innovation has become a widespread concept to improve a company's ability to innovate [17]. In addition to firms, now also individuals play an important role as a source of invention and innovation (for an overview, cf. [10]). Research contributing to this stream focuses on *user innovation*, comprising lead users [66], and ordinary users [32; 39] as well as their virtual integration for co-creation or co-design [46; 47]. Other contributions focus on the design of IT-based innovation contests [14; 22; 35]. Today's open innovation approaches profit especially from new information and communication technologies (ICT) and recent developments in the field of Web 2.0 applications – leading to a magnitude of tools for incorporating external partners in the innovation process. Moreover, ICT has

reduced the perceived distances between the actors of the innovation process while easing the integration. It is a suitable technology for aggregating millions of disparate, independent ideas and their innovators [60]. Thus, recent Web 2.0 developments open up opportunities of active integration for many partners in all phases of the innovation and value creation process. Among those Web 2.0 applications, innovation contests play a crucial role [1; 15; 16; 34].

Participants in innovation contests represent a variety of different backgrounds and form an undefined crowd of users and customers or even professional engineers and designers. Since participants can increasingly interact with each other, the question arises which of those groups profits most from external feedback provided by other participants (e.g. via functionalities for commenting). Taking an absorptive capacity perspective [18], it can be expected that a reasonable level of prior knowledge is needed. Relevant knowledge for the generation and development of innovative concepts can be divided into knowledge concerning the needs of (potential) users as well as knowledge concerning solutions to satisfy these needs [36]. Findings of a number of empirical studies on the sources of innovation in the fields of industrial as well as consumer goods [e.g. 67; 23; 24] show that users might contribute to the design of new products by using need-based as well as solution-based information [65].

As shown by several empirical studies, a person's *lead userness* is significantly related to the likelihood of generating commercially attractive innovations [e.g. 23; 24]. Lead users are characterized by their progressive needs, which are thought to be *ahead of trends* and mass market, and the strong desire to have these needs satisfied, thus expected to *highly benefit* by the realization of solutions to their needs [67].

Next to lead userness, *expertise* in terms of technical and developmental knowledge is a central driver for generating novel and useful innovation concepts [3]. By increasing their level of expertise, engineers develop a better understanding of the product components and, thus, their innovations have a higher probability of success because they can avoid elements that failed in the past [64]. More generally, the more competence and experience innovators possess, the higher the expected quality of their solutions [e.g., 33; 69; 38). Generally, individuals and groups who have to complete creative cognitive tasks tend to apply knowledge that is already in their possession [53; 41]. Various empirical studies indicate that individuals will inadvertently use prior knowledge in creative problem solving even if told not to do so [41]. Still it is unclear which type of knowledge is needed. Thus, we ask the following research question:

Do participants of innovation contests need prior knowledge to adapt external feedback and if so,
how do resulting knowledge configurations impact the creativity of submissions?

Focusing on the design elements of innovation contests as identified by Bullinger et al. [15] in the context of a systematic literature review, the paper proceeds as follows: In section 2, the current understanding of online innovation contests is presented; with a special focus on the design element "community functionalities". In section 3, we apply absorptive capacity as theoretical lens to investigate the use of external information sources in dependence of own knowledge. Further, in section 4 the method is introduced by presenting the empirical field, an innovation contest run as large scale field experiment, and analysis of its data. Subsequently, in section 5 results are shown with regards to the configuration of own knowledge stock and feedback use, and its impact on the creativity of submissions. We close our paper with the discussion of our findings and an outlook (section 6).

2. DESIGN ELEMENTS OF INNOVATION CONTESTS

An innovation contest[1] is an IT-based and time-limited competition with global reach that challenges innovators to use their skills, experience and creativity in order to come up with a solution for a particular task, i.e. the contest challenge, defined by an organizer [15]. Innovation contests are not new, but manifested since a surprisingly long time. Early examples date back more than 450 years, when the king of Spain initiated the Spanish Longitude Prize in order to discover a method to find longitude at sea [42]. What makes a major difference between the early Spanish variant and today's innovation contests is the use of online platforms to involve potential innovators from inside and outside the organization, i.e. employees, users, experts and partners, in the innovation process. Since the emergence of the Web and the existence of novel ICT, contests run through the use of online platforms. The corresponding online platform's design is central to the activities within the scope of the innovation contest. On the basis of a set of various design elements, innovation contests can be designed according to their underlying purpose. Taking into consideration literature and practice, ten design elements of innovation contests have been delimited. These are: (1) media used, (2) the organizer of an innovation contest, (3) the task specificity, (4) the required degree of elaboration of the submission, (5) the target group addressed, (6) participation form, (7) its run time, (8) the rewards granted, (9) the evaluation and, (10) community functionalities. Innovation contests can be designed in different ways by using this variety of design elements, always according to the objectives of the organizer. The importance of design is well recognized in information systems literature [28; 70; 71]. Much of the work performed by information systems practitioners and managers in general [11] deals with design – the purposeful organization of resources to accomplish a goal. For innovation contests, the combination of design elements is crucial as it influences activities of participants on the platform.

This is especially true for functionalities which allow commenting and evaluating submissions of an innovation contest. These functionalities are currently becoming more and more popular [40]. They are known to internet users from various Web 2.0 applications and are, for instance, important elements of recommendation systems. From Amazon to YouTube, customers, users and other interested individuals use their knowledge and experiences to decide for or against a product, service or user generated content. Among other things, these community functionalities could be used to increase the quality of submissions, e.g. in terms of creativity, and are of particular interest in this paper. Community functionalities facilitate intrinsic

[1] We follow Bullinger et al. [15], who suggest the term "innovation contest" instead of "idea contest" whenever the focus reaches beyond pure idea creation and potentially covers the entire innovation process from idea creation and concept generation to evaluation, selection and implementation (see also [64]).

and social motivation, support the contest and encourage its participants [14; 54]. Further, online platforms with community functionalities, including user profiles, discussion boards, chat, commenting or evaluating functionalities, allow further discussing and sharing insights with like-minded people. Users can evaluate which idea or design they like best or discuss various topics by leaving comments at other users' pin board. Thereby, comments often contain considerable suggestions for improvements of ideas or concepts. Thus, employees, users or customers provide other participants, in fact their competitors, with valuable feedback. Herewith, collaborative refinement and development of initial ideas can be supported. This potential enhancement of submissions quality in an innovation contest is according to a study of Moeslein et al. [44] also among the main drivers to integrate these functionalities of commenting and evaluating into the design of the underlying platforms. Quality of submissions is in IT-based innovation contests often measured in terms of creativity [e.g. 56]. For a valid measurement of creativity, researchers often suggest the two dimensions *novelty* and *usefulness* [2; 43; 49; 55]. *Novelty* is mostly defined as being unique or rare, meaning that new ideas have never been expressed before [36]. Other attributes belonging to novelty are originality [7; 58] and paradigm relatedness [7; 45; 22]. *Usefulness* is the extent to which the innovation responds to or solves a problem [2; 19] and is also denoted as an innovation's value or relevance [37; 32; 19]. Next to novelty and usefulness, the elaboration of an innovative concept is often used [2; 54]. Elaboration can be seen as the extent of being complete, detailed and well understandable [19]. Besides creativity related measures, other criteria like *feasibility* [32; 39; 56] or *market potential* [39; 29; 26], are of major relevance.

As a result of its potential to support and encourage participants, community functionalities are of increasing interest to scholars in the area of open innovation and especially in the context of IT-based innovation contests. In their study of the OSRAM contest 'LED – Emotionalize your light', Hutter et al. [31] analyzed submitted ideas as well as qualitative comments through which members explored and built relationships, supported each other, provided feedback but also challenged others. Next they analyzed whether these comments are collaborative or competitive in nature. Their findings show that the behavior of users was rather collaborative. In the context of the SAPiens innovation contest, Leimeister et al. [34] designed organizational as well as technical components to stimulate people to participate. Based on observations and archive analyses, they examined how activation-enabling functionalities can be systematically designed and implemented to foster active participation. They explored that especially via community functionalities (e.g. discussion board or Skype casts) members interact with one another. Thus, they reasoned that design measures had a positive impact on active participation. Blohm et al. [9] used the SAPiens innovation contest to explore the effect of user collaboration on idea quality. Their research showed that user collaboration in idea competitions is a viable design element for positively influencing idea quality. Their field test showed that implanting collaboration tools in idea competitions such as wiki technologies could be a viable measure for activating customers. They concluded that initiators of idea competitions should implement collaboration functionalities on the platform for making participants collaborate. Finally, Bullinger et al. [15] analyzed a data set of a community-based innovation contest run in 2009 at one of the leading universities in Germany and showed that participants with very high or very low level of boundary spanning generate more creative submissions in innovation contests. It can be assumed that teams differ in the knowledge sources they possess and, therefore either solely rely on their competencies (if the knowledge stock is high) or on external knowledge, if their knowledge stock is low. Whether this is the case, and if so, which configurations of knowledge determine impact resulting creativity of submissions, requires examination.

3. ABSORPTIVE CAPACITY

Though, there are already studies which confirm the potential of community functionalities with regard to collaboration and integration of other participants' feedback, collaborating and absorbing others' feedback might be also challenging. When stepping back, Cohen's and Levinthal's [18] concept of absorptive capacity can help to understand the challenge of collaboration and integration of external feedback. They describe the absorptive capacity of firm's as the ability to access, value and utilize new external resources [18]. In their contribution Cohen and Levinthal [18] identified absorptive capacity as a determinant of innovation performance.

In the context of new product development, Piller and Walcher [54] use absorptive capacity to explain that *high information stickiness* can be due to the attributes of information seekers. They state that the lack of absorptive capacity might be the reason why an information seeker is restricted in the acquisition of information. With the purpose to find out whether and how users can contribute substantially to the early phases of radical innovation projects, Lettl et al. [35] studied cases in the field of medical equipment technology. In all cases, users were the originators and inventors of radical innovation. According to the concept of absorptive capacity, Lettl et al. [35] explained that access to interdisciplinary knowhow served to increase the creative capacity of these users.

Thus, in analogy to Piller and Walcher [54] and Lettl et al. [35], who assigned the concept of absorptive capacity to an individual level, we apply absorptive capacity to participants of innovation contests, arguing that individuals who have accumulated prior knowledge across diverse domains can be expected to have a higher ability to collaborate and to use feedback of others. This is due to the fact that prior information influences an individual's ability to retrieve and process new information suitable to solve the problem [18]. People lacking experience in a given knowledge field face more difficulties to acquire and assimilate information heavily embedded in that domain and, therefore, hardly succeed in transferring and exploiting this information. In other words, an individual needs absorptive capacity in a given field - which is a function of the individual's prior knowledge in that field [cf. 13].

Zahra and George [73] develop Cohen's and Levinthal's [18] concept further and define a firm's absorptive capacity as a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic capability. Thus, according to Piller and Walcher [54] and Lettl et al. [35] and deduced from Zahra's and George's [73] definition, an individual's absorptive capacity could be interpreted as a *set of routines and processes* by which an individual, in our study the participant, *acquires, transforms, and exploits knowledge*, e.g. from others in the form of feedback, to produce a dynamic capability. Analogue to Zahra' and George's [73] definition, *acquisition* could be defined as the individual's capability to identify and acquire external information and knowledge.

The concept of absorptive capacity provides a new lens to interpret challenges of collaboration and feedback use within innovation contests. Participants in innovation contests need to have a certain degree of absorptive capacity to acquire, assimilate, transform, and exploit feedback given by other users in terms of comments to improve their own submissions. Hence, prior knowledge seems compulsory to comprehensively profit from external knowledge. To better understand this relationship, a real-world innovation contest is used to identify different configurations of knowledge and their impact on the generation of successful innovations.

4. METHOD

Based on the various design elements of innovation contests (cf. [15], we systematically designed and implemented an innovation contest. The contest was run in the context of an undergraduate course at the School of Business and Economics at one of the largest universities in Germany. This course is compulsory for all students of the school. We were aware of the limitations of an innovation contest with students as target group, though we held that the sample was for two reasons particular suited to investigate our research question. First, participants engaging in innovation contest or comparable crowdsourcing initiatives tend to be young and well educated [e.g. 23] and are furthermore the most active segment, concerning the usage of smartphones [e.g. 34]. Second, we are able to avoid self-selection biases and can control some potentially influencing factors like age.

We use the complete data set of this innovation contest which contains contributions in the form of 265 submitted concepts and the broad range of comments through which members supported each other, provided feedback but also challenged other participants. Overall, 1198 students participated in the contest. Students had to register on an online platform to participate and were randomly matched with four colleagues to form a group. All members of the winning team received a paid trip to the GeNeMe 2010 Workshop held at the technical university in Dresden. Relevant contact information of teammates was provided on the individual profile of each participant. Further, each group was assigned one of three fields: (1) leisure and entertainment, (2) fitness and healthcare or (3) education. The task of the innovation contest was very practical and could be asked by a company alike. Students were asked to develop a (business) concept for a service innovation based on Smartphone applications in the related field, which solves an everyday problem and might have market potential. The concept had to be verbally described concerning its underlying logic, its customer benefit and its technical implementation. Additionally, participants were encouraged to visualize their concepts in form of flow charts, mock ups, drawings, photo stories or movies. Submission of concepts was done on the before mentioned platform, using a predefined form for the textual description as well as for integration of further media. Teams also had the possibility to collaboratively edit the concept on the platform until the end of run-time. By using functionalities of commenting and evaluating, participants of the innovation contest had the possibility to give comments and votes via thumbs up/down and, thus, to provide feedback on others' work. They could not only interact with their own teammates but also with the rest of the community. The availability of user profiles containing of personal information and pictures added to community building. In total 265 concepts were developed during a run-time of six weeks (44 days). Further, 810 comments (with 177 words on average) and 9011 votes were given, yielding in an average of 3.06 comments and 37.86 votes per concept. Subsequently, an evaluation of the concepts was conducted by experts in the field (for details see section 3.3).

In addition to the data set of the innovation contest, we use data from a voluntary online survey with individual participants (n=961). The survey was provided to the students via email, directly after closing the innovation contest. It was promoted twice during lecture and a further reminder via email was sent out after two weeks. Overall, 961 questionnaires were returned. Elimination of incomplete questionnaires led to 827 remaining questionnaires. In cases of multiple participations (23 times) answers were compared and if answer behavior was nearly congruent, the more recent version was considered, if not, both datasets were excluded. This procedure resulted in a final set of 804 questionnaires included in the analysis. Participants were to 49.8% male and to 50.2% female, building a balanced foundation. Study backgrounds were management (62.1%), international business (6.9%), information systems (6.7%), industrial engineering (11.2%), social economics (10.6%) and business education (2.5%). Since this study examines knowledge configurations and related use of feedback on a team level, we only considered teams with at least three (out of a maximum of five) team members returning the questionnaire. This led to 198 teams taken into account for the analysis.

Measurement of independent variables was done on the basis of three relevant constructs including (1) expertise consisting of *development knowledge* (DK) and *technical knowledge* (TK) on applications for Smartphones. Measurement of development knowledge (DK) and technical knowledge (TK) are based on scales adapted from Poetz and Schreier [56]; Franke et al. [23; 24] and Ozer [52]. Both constructs consist of three items. Exemplary for the first construct is the item "*I already had experience with the development of ideas/concepts for applications in school, during study or apprenticeship*." Further items focus on this knowledge type from other backgrounds like professional experience or leisure time. Technical knowledge encompasses items like "*Regarding applications I consider myself as tinkerer*". Further, constructs included (2) individual need-information on applications in terms of *lead userness* (LU) consisting of the two dimensions ahead of market and high expected benefit. Lead userness (LU) is measured with four items for the dimension *ahead of market* and three items focusing on the *high expected benefit*. Ahead of market encompasses items like "*In general, I discover new applications earlier than others*", while one representing the latter is "*In my opinion there are many unsolved problems regarding applications"*. Scales are adopted from [56; 24; and 52]. Finally, the usage of third party knowledge in form of (3) *feedback* (FB) on the contributions was asked. Feedback use (FU) is based on the scale used by Franke et al. [26] in their experiment on the impact of feedback in mass customization initiatives. Five items like "*Other peoples' tips were very important for the further improvement of our concepts*" are used to assess the use and relevance of feedback. All items were measured on an anchored 5-point Likert scales, with 1 "*I totally disagree*" to 5 "*I totally agree*". Appendix 2 provides an overview of the independent variables, corresponding items and their descriptions.

Assessment of the concept creativity (CR) as *dependent variable* is done on the basis of a 4-point scale with 10-items. Each scale point is labeled. Eight items are used to assess sub-dimensions of novelty and quality (workability, relevance and specificity) of concepts and build on the research of Dean et al. [19]. Since market potential is part of the task, additional items were integrated into a separate variable, partly based on [54] (see Appendix 2 for details). Examples are items like "*the degree to which the idea is not only rare but is also ingenious, imaginative, or surprising"* (novelty) or *"the degree to which the idea can be easily implemented"* (workability). Since really good concepts should rate high in all dimensions, results were summed up to an aggregated score for each innovation concept. The evaluation was conducted by 12 experts in innovation management and in information systems, who independently rated the concepts on a dedicated online platform, where the concepts were presented in random order, following the guidelines of Amabile [3] and in analogy to similar studies [e.g. 7; 56]. Each concept was at least evaluated by two persons, whereas four raters were assigned to each of the three topics. Thus, six evaluator groups arise. *Intraclass correlation coefficient* (ICC) was calculated for each rater group to validate the reliability of the evaluation. Results are 0.62, 0.40, 0.36, 0.61, 0.42 and 0.48. Although values should exceed 0.7, an ICC below 0.7 can suffice in case of a homogenous sample concerning the unit of analysis [72: 160-161]. The more, "given the difficulty of the specific task [of] predicting the attractiveness of potential new products" [57: 14] Further, all of the six ICC's are significant. Therefore, inter rater reliability can be judged satisfactory.

Considering the research question, which knowledge configurations "determine" the use of external feedback and how those impact the creativity of submissions, the following three steps were used for data analysis: (1) *factor analysis*, (2) *cluster analysis* and (3) *ANOVA.*

First, to extract underlying factors an explorative *factor analysis* was carried out with the supporting software SPSS 18.0, yielding satisfactory results.

Second, *cluster analysis* was used to identify different knowledge configurations. A two-step cluster analysis helps to define the optimal number of clusters to be extracted (hierarchical cluster analysis), while the final clusters are based on the k-means clustering algorithm.

Third, an *ANOVA* was used to examine the influence of those different knowledge configurations on the overall creativity of the submissions. Again all analysis was supported by the software SPSS 18.0.

5. RESULTS

Factor Analysis

Results of the explorative factor analysis show that MSA for all items was above the suggested value of 0.6 [4]. Further, Cronbachs alpha for all factors exceeded the required minimum of 0.7 [51]. Details are shown in table 1.

Table 1. Test of Latent Construct Measurement

Construct	*Items*	*FL*	*EW*	*a*	*IR*	*CR*	*AVE*
Develop-ment Know-ledge (DK)	DK1	.830	2.028	.754	.528	.77	.54
	DK2	.783			.390		
	DK3	.853			.644		
Technical Knowledge (TK)	TK1	.787	1.897	.703	.411	.71	.45
	TK2	.831			.597		
	TK3	.766			.359		
Lead Userness (LU)	LU1	.879	3.406	.876	.869	.88	.60
	LU2	.876			.854		
	LU3	.842			.804		
	LU5	.787			.703		
	LU7	.734			.638		
Feedback Use (FU)	FU2	.814	2.882	.809	.679	.81	.52
	FU3	.685			.597		
	FU4	.852			.891		
	FU5	.760			.701		

The two dimensions of lead userness clearly load on one single factor, indicating the construct of lead userness as one-dimensional in our study, and are aggregated to one factor. Confirmative factor analysis (conducted with the software AMOS 5.0) supports the results but leads to the exclusion of two (out of seven) LU items and one FU item (FU1). Indicator reliability should exceed 0.4, which is met by almost all items or at least close enough (i.e. DK2 and TK3)[2]. Composite reliability (CR) as well as the average variance explained (AVE) yield satisfactory results (cf. table 1). Literature suggests thresholds of >0.6 for FR and >0.5 for average variance explained for convergence validity [e.g. 5]. Reliability is further supported by overall fit statistics[3] which exceed the required thresholds. The goodness-of-fit-index (GFI), the adjusted goodness-of-fit-index (AGFI) and the comparative-fit-index (CFI) surpass a minimum value of 0.9. LU: GFI=0.991, AGFI=0.974, CFI=0.994. FU: GFI=0.996, AGFI=0.987 CFI=1.0. RMSEA fulfills the rule of <0.08 for acceptable model fit (LU: RMSEA=0.055; FU: RMSEA=0.000).

Cluster Analysis

New aggregated variables were calculated, representing the above identified factors. These were averaged by the amount of team members participating in the survey to represent the average level of each knowledge source as approximation for the overall group knowledge level and finally normalized. To prepare data for cluster analysis an exploratory analysis of data, focusing on the assumption of normal distribution and potential outliers was undertaken. Due to outlier analysis eleven teams were eliminated, since cluster analysis is very sensitive on those, leading to a final set of 187 teams. Although none of the variables has a perfect normal distribution, examination reveals an adequate level for cluster analysis. Further, the high number of cases makes cluster analysis more robust against violations of assumptions.

To identify the ideal number of clusters to be formed, a hierarchical cluster analysis based on the Ward-method was conducted. Hierarchical cluster analysis starts with every case being an own cluster and sequentially combines clusters with lowest distance until all cases are unified to one cluster [59]. In a second step, the user has to decide on the solution in terms of cluster number which seems to be the most appropriate. Heuristically, a criterion to support this decision is the squared error term, which can be depicted as graph consisting of these error terms versus the number of clusters. This visualization is also named the elbow criteria due to its characteristic shape. The

[2] However, if sample size is above 400, also values between 0.2 and 0.4 are acceptable [6: 117].

[3] Applies only to constructs measured with more than three items.

optimal number of clusters is the iteration step at which the highest difference occurs, thus, where the graph bends. In our case the analysis resulted in a four cluster solution.

A second cluster analysis served to determine the clusters. In analogy to the approach of Franke and Doemoetoer [25] who apply cluster analysis to identify success strategies of innovative SMEs, we use k-means clustering to examine different configurations of knowledge sourcing. The k-means cluster algorithm groups objects in a way that the variance within clusters is minimized while it is maximized between the clusters [59]. Input variables were the above defined sources of knowledge concerning own need- and solution-information as well as the use of external knowledge. An overview of the results is provided in table 2.

Table 2. Results of Cluster Analysis

Variable	*Cluster 1* [a]	*Cluster 2* [b]	*Cluster 3* [c]	*Cluster 4* [d]	*Sig* [e]
DK	1.69	1.34	1.95	1.23	<.001
TK	2.23	1.63	2.28	1.78	<.001
LU	1.93	1.45	2.01	1.40	<.001
FU	2.03	2.31	3.01	3.51	<.001

[a] n=35; [b] n=65; [c] n=46; [d] n=41; [e] ANOVA

Variable means of all clusters were tested by ANOVAs and revealed that they are highly significant distinct.

Cluster 1 is mainly characterized by its marginal use of feedback (FU=2.03). All remaining knowledge sources (DK=1.69 and TK=2.23) as well as need-information (LU=1.93) on the other hand are well developed. We term this cluster the *"experts"*. The reason why these teams use feedback only slightly might be that they are more involved with feedback giving. Thus, teams of this cluster mainly trust in their abilities and, due to laziness or competitive orientation, are not interested in interaction with other participants.

Cluster 2 is not only characterized by a rather low use of feedback with a value of FU=2.31, but also by an under average occurrence of solution information in terms of development (DK=1.34) and technical knowledge (TK=1.63) as well as considerably low values concerning need-information (LU=1.45). We refer to this cluster as the *"crowd"*. Such teams might be interesting for organizers of innovation contests because they represent the 'average joe' of innovation contest participants, i.e. people possessing general, but not specific skills. Attraction and activation of such teams in innovation contests should be further researched.

Cluster 3 is characterized by high values across all knowledge sources. While all of them are crucial for the description of cluster 3 and clearly exceeding the mean, expertise in terms of development knowledge (DK=1.95) as well as technical knowledge (TK=2.28) slightly dominate. Because of their high expertise, teams in this cluster might be essential for other teams as feedback givers. Lead user characteristics (LU=2.01) and feedback use (FU=3.01) contribute as well. Overall, teams in this cluster possess knowledge on needs and solutions related to Smartphone applications, while including external knowledge to enhance their work. We want to term this cluster the *"listening experts"*.

Cluster 4, finally, is determined by its low expertise (DK=1.23 and TK=1.78) and also scores very low on the lead user characteristics (LU=1.40). Concerning the use of feedback (FU=3.51), however, a different picture appears. Teams in cluster 4 heavily rely on the suggestions of others and, thus, on external knowledge. We name this cluster the *"listening crowd"* and assume that teams in this cluster participate in innovation contests because of the available *community functionality* which exactly allow the exchange of comments. All four clusters of knowledge configurations are presented in figure 1.

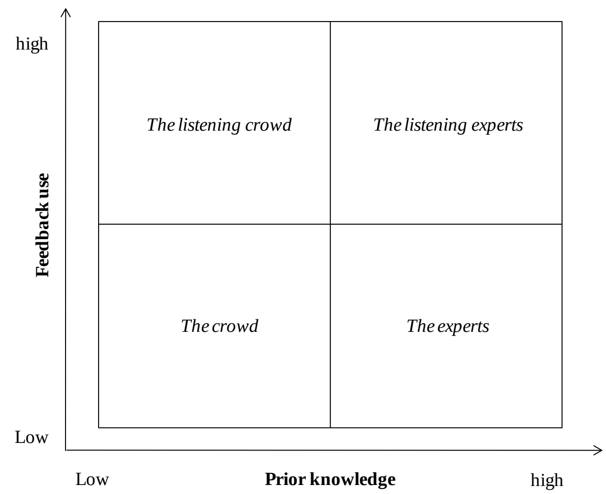

Figure 1. Clusters of Knowledge Configurations

ANOVA

Results of the ANOVA help to answer the question whether these distinct configurations of knowledge, lead userness and feedback use impact the overall outcome of the teams. The identified clusters were used as independent variables, while the outcome was assessed as metric variable in form of an averaged overall score of the six variables outlined in appendix 2. Hence, theoretical range of values is between 3.0 and 7.66, while the actual extreme values were 3.08 and 6.98. Table 3 provides relevant results of the ANOVA.

Table 3. Results of ANOVA

Variable	*Cluster 1* [a]	*Cluster 2* [b]	*Cluster 3* [c]	*Cluster 4* [d]	*Sig* [f]
CR [e]	5.26	5.00	5.17	5.49	<.001

[a] *experts;* [b] *crowd;* [c] *list. experts*; [d] *list. crowd;* [e] total average = 5.2
[f] R=.293, R^2=8.6%

Differences between the three groups are marginal, still highly significant (p<.001). The group with the lowest average concerning the creativity of submissions (CR=5.00) is cluster 2, which also scored lowest on all knowledge sources. Thus, although having a limited knowledge stock, external feedback was not provided or not used, either due to a lack of interest or capability. Cluster 3 already achieves a higher average on creativity of submissions (CR=5.17). Interestingly, this cluster consists of teams with expertise and lead userness, who integrated external knowledge. Cluster 1, encompassing lead users and experts only marginally using external feedback, achieve slightly better results (CR=5.26). The overall winner, however, is cluster 4, the smart crowd. Those, although possessing under average expertise and lead userness but integrating by far the most of external knowledge, have the highest average of creativity of submissions (CR=5.49).

6. DISCUSSION & OUTLOOK

Results of data analysis have led to interesting insights concerning the research question on necessary prior knowledge of participants in an IT-based innovation contest and impact of potentially resulting knowledge configurations on the creativity of submissions. First of all, data has shown that prior knowledge is not a precondition to extensively profit from feedback. This is particular interesting, since it contradicts the theoretical assumptions of individual absorptive capacity, namely that prior knowledge is relevant to successfully assimilate new knowledge. Second, participants who possess little prior knowledge cannot only generate concepts of similar quality as their more experienced counterparts, but even outperform them if provided with feedback. Third, resulting knowledge configurations show distinct possibilities to achieve top quality submissions in IT-based innovation contests. Putting together, results support existing knowledge on the design of IT-based innovation contests [cf. 21; 34] and contribute to the body of knowledge on open innovation [cf. 56], as well as to the theoretical lens of absorptive capacity [cf. 73].

Participants of cluster 1 (*"experts"*) do not display absorptive capacity by using 'community functionality'. They have a considerably high amount of prior knowledge relating to needs and solutions for Smartphone applications. But despite being less knowledgeable than the *"listening experts",* they do not seem to be interested in the reflections of external persons. They solely count on their own knowledge and do not have confidence in others' opinions. This cluster stands in line with the results of Bullinger et al. [15] who found that highly competitive participants can deliver highly innovative results in IT-based innovation contests. In terms of design, this cluster does not require the design element 'community functionality'. Still, *incentives could stimulate feedback* giving, which could be of interest for the organizers, since this cluster seems to possess relevant knowledge.

The same applies for cluster 2 (*"crowd"*). For them the design of an IT-based innovation contest seems little relevant. They are neither equipped with prior knowledge and due to that lack or due to missing interest do not show any absorptive capacity. They participate in an IT-based innovation contest for reasons that need further research, but show only little interest in other people's opinions expressed via commenting. Reasons for their participation might be in line with findings of Nonnecke and Preece [50], who found that lurkers in online groups have a set of different reasons for their behavior, like e.g. work constraints. These reasons might apply for IT-based innovation contests, too. In terms of the design element 'community functionality', the *"crowd"* does not represent any requirements.

Taking the lens of absorptive capacity, cluster 3 (*"listening experts"*) is willing and able to acquire, transform, and exploit knowledge, e.g. from others in the form of feedback [73; 35]. Participants who fall in this cluster are well equipped with extensive knowledge on the needs as well as the solutions for challenges in the realm of Smartphone applications. Though, they actively acquire knowledge by listening to the outside world and welcoming suggestions for improvements. The *"listening experts"* like to prove their skills, but they are never shy of knowledge. Moreover, they enjoy feedback as well and, thus, are feeling very comfortable on open innovation platforms. These persons hold the potential to be the IT-based lead users for open innovation platforms in general. However, this group performs slightly less (in terms of creativity) than the pure "experts". One reason might be the information overflow by extensive own knowledge and external feedback. Thus, *community functionalities should encompass the possibility to reduce and select information*, e.g. by evaluation of comments by other participants.

Cluster 4, the *"listening crowd"*, does not show complete prior information concerning needs and solutions in the domain of Smartphone applications, but is heavily using external feedback. The listening crowd is outstanding in their absorptive capacity as it is both well aware of the potential of other peoples' suggestions for compensating missing knowledge and using this external knowledge. Its ability to generate top quality submissions *without* significant prior knowledge is most important and contra intuitive to the assumptions of absorptive capacity. For cluster 4, our results further the findings of Bullinger and colleagues [15] who showed that a high degree of cooperative orientation leads to a high degree of innovativeness and claim research on necessary design elements. In this context, findings are also in line with Magnusson [39] who found that ordinary users, who get some technical guidance, create better solutions (in terms of novelty, feasibility and usefulness) than users without support and even better than professional product developers. Our data shows that to generate and maintain motivation of these *listening* participants, an IT-based innovation contest needs *extensive commenting and messaging functionalities such as pin board messages, comments or chat functionalities*. Without the design element 'community functionality' being realized, these participants cannot unfold their full potential. In one sentence, one can say that for IT-based innovation contests knowing is silver, listening is gold.

Findings of this study have to be seen in the light of its limitations. As we base on a student contest, it needs to be tested whether the same clusters will be found in a corporate context. Given the business-oriented challenge of the examined IT-based innovation contest, we expect our findings to be strengthened by this comparison. The task and the corresponding three different domains of application in this innovation contest were chosen in such a manner that every participant should have a comparable set of know-how and experience. Though, innovation contests with a more narrow or specific task, could not only be influenced by development and technical knowledge, but moreover by domain knowledge. When analyzing such innovation contests, domain knowledge should be examined in more detail.

In addition, the examined contest has not been influenced by the organizers in terms of moderation. Hence, the question remains, whether the design element 'community functionality' as a technical element should be enriched by human moderation or facilitation activities as researched in the field of GSS [12; 48; 20; 29] or communities of practice [61; 62]. Finally, 'community functionality' like commenting and voting can serve as filter or even substitute for traditional jury evaluation approaches, which has not been explored by the study at hand. Forthcoming studies should target a better understanding of the design elements 'community functionality' and 'evaluation'.

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9. APPENDIX

Appendix 1. Scales for Measurement of Independent Variables

Variable	*Item*	*Description*
Develop-ment Know-ledge	DK1	I already had experience with the development of ideas/concepts for applications in school, during study or apprenticeship.
	DK2	I already had professional experience with the development of ideas/concepts for applications.
	DK3	I already had experience with the development of ideas/concepts for applications in my free time.
Technical Know-ledge	TK1	I am very well schooled in applications.
	TK2	I am especially interested in the technical implementation of applications.
	TK3	Regarding applications I consider myself as tinker.
Ahead of Market	LU1	In general, I discover new applications earlier than others.
	LU2	In the past I have benefited very much of using applications.
	LU3	Regarding purchase and usage of applications, I am often asked for advice.
	LU4	I have already tried to modify existing applications to improve application possibilities.
High expected Benefit	LU5	I had already problems with applications which could not be solved by commercial offers available.
	LU6	In my opinion there are many unsolved problems regarding applications.
	LU7	I have needs regarding Smartphones and applications which could not be solved / satisfied by means of existing offers.
Feedback use	FB1	Our final concept is depending on other peoples' recommendations.
	FB2	Other peoples' tips were very important for the further improvement of our concepts.
	FB3	We have got feedback of other people on our concept.
	FB4	We have included suggestions for improvement of other people into our concept.
	FB5	We have created our concept without obtaining tips or suggestions of others.

Appendix 2. Scales for Measurement of Idea Creativity

Variable	*Factor*	*Item*	*Description*
Novelty	Originality	N1	The degree to which the idea is not only rare but is also ingenious, imaginative, or surprising.
	Paradigm relatedness	N2	The degree to which an idea preserves or modifies a paradigm. PM ideas are sometimes radical or transformational
Work-ability	Acceptability	W1	The degree to which the idea is socially, legally, or politically acceptable.
	Implement-ability	W2	The degree to which the idea can be easily implemented.
Relevance	Applicability	R1	The degree to which the idea clearly applies to the stated problem.
	Effectiveness	R2	The degree to which the idea will solve the problem.
Specificity	Complete-ness	S1	The number of independent subcomponents into which the idea can be decomposed, and the breadth of coverage with regard to who, what, where, when, why, and how
	Implicational explicitness	S2	The degree to which there is a clear relationship between the recommended action and the expected outcome.
Market Potential	Customer acceptance	M1	The degree to which the idea should be realized in its actual status.
	Beneficiary	M2	The degree to which the idea solves a relevant problem many people are facing.