Ideate. Collaborate. Repeat. A Research Agenda for Idea Generation, Collaboration and Evaluation in Open Innovation

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Abstract. Open innovation has been and remains to be a rapidly changing field of research in Information Systems and various other disciplines. With the rise of professional open innovation platforms and the emergence of crowdsourcing as well as employee-driven innovation, studies on the front-end of open innovation – namely idea generation, collaboration and evaluation – are facing new challenges. In this structured literature review, we analyze a large body of prior research in order to derive a framework, which is able to classify and reflect the lively debate on open innovation. In addition, we identify important implications for practitioners with advise on the design of open innovation systems. Moreover, our study identifies several promising areas for future research.

Keywords: open innovation, literature review, generation, collaboration, evaluation

1 Introduction

More than a decade after its conceptual inception by Chesbrough [12], open innovation (OI) still receives remarkable attention by scholars. It developed into an established research field in Technology and Innovation Management as well as Information Systems [17]. Many organizations, including public and corporate agents, have established OI platforms to solicit innovative ideas from a broad base of users. OI is an important means to create disruptive business innovations, rapidly changing existing and shaping new business models, processes and products [2]. For instance, Dell's ongoing "IdeaStorm" generated more than 20,000 suggestions for product improvements from thousands of registered users [6]. Because of such vast numbers of participants and proposals, an OI contest is likely to produce superior ideas and solutions that are able to compete with experts and innovators from corporate research and development (R&D) units – a proposition in line with the "wisdom of the crowds" theory [2, 31, 45, 47]. However, previous research suggests that these large idea collections in OI processes also tend to produce a number of highly redundant ideas and suggestions that greatly vary in terms of quality [8, 45, 46]. While about a third of

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the ideas might be great, a majority is either mediocre or of low quality and is hence discarded as scrap [46, 28]. This is one reason why organizations often refrain from having their own experts evaluate each proposal, and resort to ask all users in an OI engagement to collectively evaluate and develop ideas further.

The environment for OI platforms is rapidly changing. At the beginning, many firms tried to set up proprietary OI systems, but with the rise of crowdsourcing [23] and professional OI platform providers (e.g., Hyve, Exago), OI might turn into a common form of R&D in leading corporations, as well as being more easily accessible to small and medium-sized enterprises (SMEs) and even individuals [17]. Moreover, with the emergence of topics such as employee-driven innovation [21, 13] and computer-supported organizational participation [57], OI might face new requirements within firms. Moreover, while process facilitators of OI engagements were able to profit from its novel character for a long time, they might face the problem of engaging less technology-savvy users and keep users engaged and active over a longer period of time going forward – both inside and outside the company. Considering the recent surge in research publications on OI and the changing environment for it, there is a need for a unified and structured framework that is able to both classify prior studies and guide future research.

In this paper, we therefore explore how extant research has analyzed the determinants for idea generation, collaboration and evaluation in OI – representing the key elements of the OI front-end [24] – to derive lessons on how OI systems need to be designed in the future in order to produce innovative solutions. In effect, we can also highlight areas for future research.

To do so, we analyzed 50 articles identified by means of a structured literature review [60]. In order to support researchers and practitioners in identifying well-studied and under-researched areas, we provide a concept matrix and a related framework that illustrate the flow of typical OI processes with the most relevant components. Both classify and summarize the studies along the sphere and sources the OI system addresses, the type of IT artifact, as well as the subject, testable propositions and methodology of the research. Our findings illustrate that idea generation and idea evaluation were almost equally often considered by the literature, mostly analyzing the collaboration processes. We find that researchers often recommend interactive ideation processes to increase the proposals' potential. Moreover, using multi-attributive rating scales was regularly found to strengthen decision quality. We criticize that many researchers developed OI systems on their own, rather than adopting prior development. Finally, we highlight areas for future research, including researching phenomena such as information cascades as well as the difference in idea generation and evaluation by internal versus external crowds.

In what follows, we explore the background and set the boundaries of our research in Section 2. We then introduce our methodology in Section 3 and describe the literature review process in detail. In Section 4, we report our results and discuss implications for practitioners as well as future research in Section 5. Section 6 draws a conclusion.

2 Background

For more than a decade, research on OI has been and continues to be a rapidly emerging and developing field of study in Information Systems and various other disciplines, such as Economics and Management Science [24, 2, 61]. Unsurprisingly, scholars have proposed a number of definitions and models that aim to describe OI. For the purpose of this literature review, we use a broad approach by Chesbrough [12], who defined OI as the use of purposeful inflows and outflows of knowledge to stimulate internal innovation, and expand the markets for the external use of innovation.

In practice, OI is often implemented using an idea contest. Adamcyzk et al. [2] referred to this as IT-based and time-limited competitions by organizations calling on the general public or a specific target group to propose innovative solutions. In doing so, the organizers make use of the expertise, skills and creativity of a crowd of users.

Hrastinski et al. [24] classified OI systems as technologies for idea management, problem solving and innovation (analysis). Their front-end typically comprises features and processes that support users in generating proposals and, consequently, developing and evaluating them. The systems might include sophisticated measurement tools to enable the evaluation process. Users might also be incentivized by rewards and recognition to participate in OI engagements. We will refer to these two common functionalities of OI systems as idea generation and evaluation, which can both happen with or without collaboration amongst users of the system [24].

Usually OI systems are implemented in the public sphere on one hand, by actors such as governments and non-governmental organizations. On the other hand, OI systems are especially popular with firms. Moreover, Gassmann et al. [17] suggested that universities and other academic organizations are engaging in OI too. These three broad spheres already hint at the possible target groups of OI processes. These are typically crowds that are either internal to the facilitating organization (e.g., employees, members) or external (e.g., customers, general public). In addition, OI facilitators often involve an (independent) expert committee to evaluate user-generated content [2]. Thus, considering these three broad spheres and target groups, research on OI is able to investigate various factors and their effects. Reviewing studies in Economics and Management Science, Adamczyk et al. [2] suggested that scholars are mainly concerned with assessing (1) the quality of idea generation processes, (2) the efficient design of OI processes, as well as (3) the users' motives to participate in OI engagements.

3 Research Method

In what follows, we describe our method for data collection, which builds the basis for the subsequent analysis. First, in order to provide a clear scope for this literature review, we need to set the boundaries of research [60]. We focus on what Hratinski et al. [24] referred to as the front-end of OI systems; that is, studies on computer-supported tools for the generation and evaluation of creative and valuable ideas and solutions in OI, including their collaborative development and rating. Thus, we consider the process from the point at which a facilitator opted to use an OI system until the point at which

it comes to the decision of whether and how an idea shall be implemented. Hratinski et al. [24] referred to the latter as the back-end of OI. Also, research on new product development that does not explicitly refer to an OI process (e.g., by using data from an OI platform) is hence beyond the scope of our study. Furthermore, as we expect to find a large number of research articles on OI, we need to focus on studies that contribute most to the cumulative building of knowledge in the Information Systems literature by providing an advance to previous propositions and models [20]. Thus, we only include research that proposes the design of a solution for a pre-defined problem along with some form of demonstration and/or evaluation [43, 20].

3.1 Data Collection

Following the principles of Webster and Watson [60], we conducted an in-depth topic-based literature review focusing on idea generation, collaboration and evaluation in OI systems.

As OI represents an interdisciplinary and emerging research field, we included all relevant research published in journals listed in the ABS Academic Journal Guide 2015 [1] in the research subject areas of (1) Economics, Econometrics and Statistics, (2) Information Management, (3) Marketing, (4) Innovation and (5) Operations Research and Management. As we focus on Information Systems in particular, we also included full papers published in the seven leading generic Information Systems conference proceedings as recognized by ACPHIS [3]. To this list of conferences, we added CHI as the leading conference on Human-Computer-Interaction [67].

To investigate the literature base, we concentrated on the following databases: ProQuest (ABI/INFORM), Elsevier, IEEE, ACM, JSTOR, Web of Science, and EBSCOhost. Furthermore, AIS electronic library was accessed to review relevant conference proceedings.

For the research database search, we used a set of keyword combinations. In order to cover the broader literature on OI, we paired “open innovation” with “process”, “system”, “engagement” and “design”. Additionally, we combined “innovation” with “contest” and “tournaments” as these words are sometimes used as quasi-synonyms for OI engagements. Moreover, we wanted to cover more detailed studies on the sub-processes of OI activities. Therefore, we used a broad set of words we combined with “idea”, namely “generation”, “collaboration”, “evaluation”, along with a number of synonyms such as “assessment”, “voting”, “rating”, “ranking”, “screening”, and “filtering”, as well as “competition” and “management”.

Articles published before the year 2000 were excluded from our research, since computer-supported ideation and evaluation in OI was not properly defined in the last century.

Our literature search was conducted in three steps from April to May 2016. First, keyword search resulted in 212 articles being selected based on their title and abstract. We then removed duplicates and irrelevant articles. For instance, many articles investigated creativity or evaluation techniques in closed innovation environments. Other scholars analyzed managerial consequences or the implementation process of new ideas gained from OI, which is also beyond the scope of our study. Moreover, articles from publications other than those listed in the ABS Academic Journal Guide 2015 and conference proceedings recognized by ACPHIS were excluded to ensure a

high level of quality. Second, the remaining 88 articles were analyzed in more detail focusing on their methodology and findings. Articles not satisfying the conditions set in our boundaries of research in Section 2 were excluded from our subsequent analysis. For instance, some studies implemented a system and refrained from evaluating it properly.

Articles satisfying the conditions introduced in Section 2 formed the basis of our third and last step. There, we conducted backward and forward searches, leading to 13 additional articles. In total, this structured review process resulted in a sample of 29 journal and 21 conference articles.

3.2 Data Analysis

Following Webster and Watson [60], we categorized the literature according to topic-related concepts as motivated in Section 2. First, we classified the articles based on the sphere that the study was conducted in, meaning public, corporate or academic [17]. Second, we extended our literature review by categorizing the type of source the research examined. On the basis of typical OI target groups, a source is either an external or internal crowd developing and/or evaluating ideas. Besides these crowds, an independent expert committee can also serve as a source of information [2]. Third, we also analyzed whether the research in our literature review proposed and evaluated an IT artifact of some sort. The definition of IT artifacts is subject to debate in the Information Systems literature [20]. Yet, we followed the definition by Peffers et al. [43], describing an artifact as something artificial, constructed by humans, which can be "any designed object in which a research contribution is embedded in the design" (p. 55). Furthermore, we adopted Gregor and Jones' [20] classification of artifacts in terms of models, principles and methods. We also added the category of full system, which describes whether an artifact includes models, principles and methods to enable idea generation, collaboration and evaluation. Fourth, we categorized each study by its main research subject. As we focus on the front-end of OI as defined by Hratinski et al. [24], the three categories are idea generation, collaboration and evaluation. Moreover, each article investigated OI with regards to some form of testable proposition by introducing a quantitative, statistical analysis or through heuristic propositions [20, 56]. With regard to research on OI, we categorized the studies according to whether they (1) perform quality assessment, (2) analyze the efficiency of a process or (3) investigate user motivation [2]. Additionally, we analyzed in which sphere each study was conducted in. Finally, we categorized the identified literature according to the methodology used. Building on Palvia et al. [40], we limited these categories to frameworks/models, literature reviews, case studies, surveys, mathematical models and interviews. Two researchers classified the literature independently. Few inconsistencies were discussed and re-evaluated in order to reach a common understanding and resolve discrepancies.

4 Results

Our results point out that OI in general and idea generation, collaboration and evaluation in particular, recently received increased attention by researchers (see

Table 1). Most studies were published in conference proceedings, followed by research published in leading journals (see Table 2). Moreover, retrieving 19 articles in research fields such as Technology and Innovation Management as well as Marketing, confirms that OI is a constantly evolving, interdisciplinary field of research.

Table 1. Publications by time frame

Time frame	*2000-2003*	*2004-2007*	*2008-2011*	*2012-2016*
Publications	0	6	18	26

Table 2. Publications by research outlet

ABS Ranking [1]	*4/4**	*3*	*2*	*Conference*
Publications	15	8	6	21

We developed a concept matrix that categorizes each study (see Table 3). The concept matrix follows the outline of our data analysis in that it is structured in terms of the sphere and source, the type of IT artifact as well as the subject of the study, its testable propositions and methodology. In terms of idea generation we found 11 articles, compared to 16 articles investigating idea evaluation exclusively, whereas 21 articles covered both subjects at least partially. Interestingly, we found that researchers covered collaboration only in conjunction with either idea generation or evaluation, but never as a stand-alone research subject. Collaboration was investigated almost equally for generation and evaluation (39 vs. 33). This arises from the fact that many articles investigate OI systems that rely on collaboration.

With regard to the testable proposition, the vast majority of all articles covered at least some kind of quality assessment. In many cases, studies analyzed the quality of user-generated ideas through evaluations by experts committees [e.g., 46, 8, 28, 27, 32]. Thus, the propositions were both quantitative as well as heuristic in nature [56], as the experts used standardized rating methods to express their personal evaluation. Some studies took a more quantifiable approach, for instance, by evaluating the degree of user participation and activity (e.g., based on the number of executed trades or submitted ideas) on an idea market platform [51]. Two other studies conducted social network analyses [25, 7], which assessed both quality and quantity of user interactions. Moreover, 12 studies were concerned with evaluating efficiency of the processes of an OI engagement. Most often, this was the case for research on rating scales, where scholars tested how fast and accurate participants were able to conduct an evaluation task [e.g., 46, 8, 28, 14, 5]. Only one article (despite the

Table 3. Concept Matrix

	Sphere			Sources				Subject			Testable propositions			Methodology					
	Academic	Firm	Public	experts	internal crowds	external crowd	IT artifact	Generation	Collaboration	Evaluation	Quality Assessment	Efficiency	User Motivation	Framework/Model	Literature Review	Case Study	Survey	Math. Model	Interview
[2] Adamczyk et al 2012	◐	◐	◐	◐	◐	◐		●	●	●					●				
[4] Bailey and Horvitz 2010		●		●	●		FS	●	●	●	●		●			●			●
[5] Bao et al. 2011	●					●	ME			●	●		◐			●			
[6] Bayus 2013		●				●	FS	●	◐		●		◐			●			
[7] Björk and Magnusson 2009		●				●		◐	●	◐	●					●			●
[8] Blohm et al. 2010		●		◐		●	ME	●	●		◐		●			●			
[9] Blohm et al. 2011	●			◐		●	ME			●	●		●			●	●		
[10] Boudreau et al 2011		●	●			●		●	◐				●			●			
[11] Bullinger et al 2010			●			●		●	●		●		●			●	●		●
[13] Ciriello et al. 2016		●			●		ME			●	◐	◐		●					●
[14] Dean et al. 2006	●			◐		◐	PR			●	●			●					
[16] Feldmann et al. 2014	●	●			◐	●			●	●	●		●			●			
[19] Görs et al. 2012	●					●	ME			●	●	●	●			●		●	
[22] Horton et al. 2016	●	◐				●	PR			●	●					◐	◐	●	
[24] Hrastinski et al. 2010		●	●		●	●		●	●	●	◐	◐	◐	◐	●				
[25] Hutter et al. 2011		●				●		●	●	◐	●		◐			●	●		
[26] Jung et al. 2010	●					●	ME	●	●		◐		●			●			
[27] Kathan et al. 2015		●				●	FS	●	●		●		◐			●			
[28] Klein and García 2015	●	●		◐	●		ME			●	●	●				●			
[29] Kornish and Ulrich 2011	●					●		●			●	●				●			
[30] Kristensson et al 2004		●		●	●	●		●			●					●			
[32] Lauto and Valentin 2016		●			●					●	●					●			
[33] Lee and Seo 2013		●				●			◐	●	●		●			●			
[34] Leimeister et al 2009		●		◐		●	FS	●	●	●	●		●	◐		●	●		
[35] Luo and Toubia 2015	●					●	PR	●		◐	●		●			●	◐		
[36] Magnusson et al 2014	●			●						●	●					●			
[37] Muller et al. 2013		●			●		FS	●	●	●	◐		●			●			
[38] Natalicchio et al 2014	●	●	●	●	●	●		●	●	●	●		●		●				
[41] Pashkina and Indulska 2011		●				●	MO	●			◐	◐	◐	●					
[42] Pedersen et al. 2013	◐	◐	◐	◐	◐	◐		◐	◐	◐	◐	◐	◐		●				
[44] Piller and Walcher 2006		●		◐		●	FS	◐		●	●					●			◐
[45] Poetz and Schreier 2014		◐	◐					●		◐	●					◐			
[46] Riedl et al. 2013	●	◐		◐		●	ME			●	●	●				●			
[47] Riedl et al. 2010	●	●		◐		●	ME			●	●		●			●	◐		
[48] Sawhney et al. 2005		●			●			●	●	◐	◐		◐			●			
[49] Scheiner 2015			●			●	FS	●	●	●			●			●	●		●
[50] Simon et al. 2016	●					●	FS	●		◐	●		●			●	●		
[51] Soukhoroukova et al. 2012		●		◐	●		FS	●	●	●	●	●	◐			●			
[52] Stieglitz and Hassannia 2016		●			●	●		◐		●	●		●			●			
[53] Terwiesch and Xu 2008	●					●	PR	◐		◐	●		●					●	
[54] Toubia 2006	●					●	MO	●					●			●			
[55] Toubia and Flores 2007	●	◐				●	ME			●	●	◐				◐		●	
[58] Walter and Back 2013	●		●	●		●	ME			●	●	◐		◐		●			
[59] Walter and Back 2011		●	●			●			●	●	●		●	●		●			
[61] West and Bogers 2013	●	●	●			●		●	●	●	●		●		●				
[62] Wu and Fang 2010		●				●		●	●				●			●	●		
[63] Xu and Bailey 2012		●				●	MO			●	●					◐		◐	
[64] Yu and Nickerson 2011	●					●	ME	●	◐	◐	●					●			
[65] Yücesan 2013	●					●	MO			●		●						●	
[66] Zimmerling et al. 2016		●		◐	●		FS	◐	◐	●			●				●		●

ME: Method, FS: Full system, PR: Principle, MO: Model

literature reviews) examined efficiency in collaborative idea generation; in this case by analyzing the redundancy of idea proposals [29]. Also user motivation was measured by many scholars, mostly by means of surveys or interviews. These studies asked for users' motives to participate and their satisfaction with the OI system. However, user motivation was often covered as an additional topic rather than being the main research question.

The majority of extant research investigated OI in the context of the sphere of the firm. Many papers also included an academic perspective, while only a fifth of the studies addressed the public sphere.

Many studies did not propose and evaluate an IT artifact. Surprisingly though, those that did often proposed a full OI system, which covered all the features described by Hratinski et al. [24] as the front-end of OI systems. Among them, many were studies in the domain of gamification, which focused on topics of user involvement through gamified reward systems and rankings to provide a gripping user experience [49, 66, 16, 54].

Most studies dealt with an external crowd as its source for idea generation, collaboration and/or evaluation. Other studies contributed to the overall trend of employee-driven innovation by sourcing ideas or evaluation from an internal crowd of employees [4, 13]. Moreover, some studies asked experts to assess the quality of user-

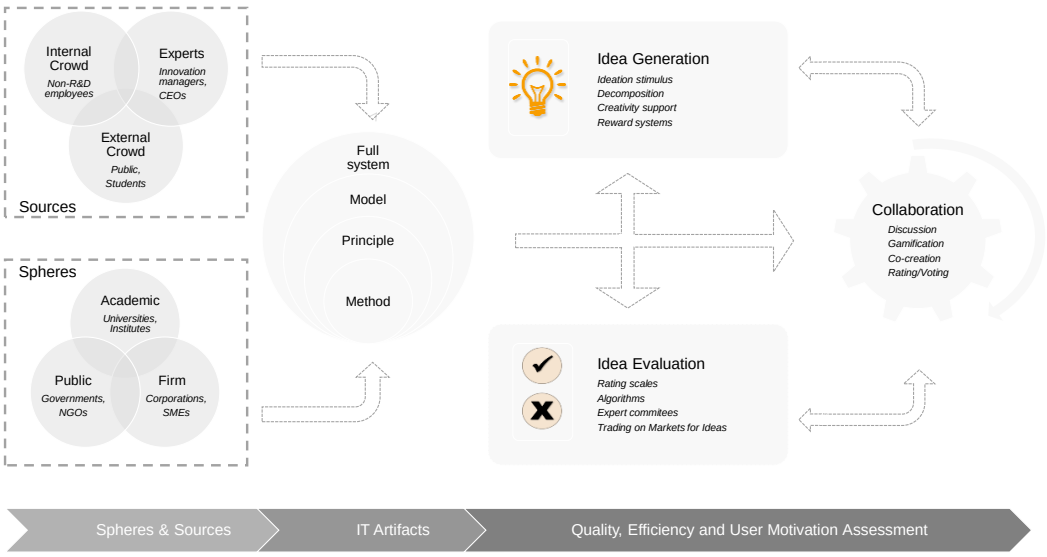

Figure 1. Framework for idea generation, collaboration and evaluation in OI

generated ideas or ratings. Magnusson et al. [36] was the only study to solely focus on experts as a source of information. The study analyzed different idea screening procedures by asking experts to rate ideas retrieved from an OI contest.

In terms of the methodologies, we find a rather clear picture. Despite the variety of research areas covered in our literature review, the vast majority of articles employed

case studies [4, 5, 6, 7, 8, 9, 10, 11, 16, 19, 22, 25, 26, 27, 28, 29, 30, 32, 33, 34, 35, 36, 37, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 58, 59, 62, 63, 64]. Scholars either set up their own OI systems and applied them in practice – collaborating with firms, students or the general public – or extracted data from existing OI platforms (e.g., Dell's IdeaStorm [6] or Starbuck's MyStarbucksIdeas.com [4]). These case studies were sometimes supported by surveys [9, 11, 22, 25, 34, 35, 47, 49, 50, 62, 66] and/or interviews [4, 7, 11, 13, 44, 49, 66] in order to explore users' motives to engage in and perception of OI engagements. Seven studies developed frameworks and models of OI [13, 14, 24, 34, 41, 58, 59]. Moreover, six studies developed mathematical models in order to investigate the optimal design of OI processes [19, 22, 53, 55, 63, 65]. Furthermore, we found five literature reviews [2, 24, 38, 42, 61]. They were at least two years old and examined distinctively different research questions than our study. For instance, they examined literature on boundary areas of OI, such as markets for ideas [38] or crowdsourcing [42].

Investigating lessons for the design of OI systems, we find that idea generation and idea evaluation were almost equally often considered by the literature. Most studies did so by also analyzing the collaboration processes. Both Bullinger et al. [11] and Blohm et al. [8] suggest that collaborative ideation outperforms non-collaborative approaches. Moreover, research [18] established that the point in time when users are involved in collaborative processes is crucial. Moreover, Luo and Toubia [35] also emphasized that decomposing an idea and providing stimulus ideas can significantly change the outcome of an idea generation phase. Several studies highlight that the decomposition of the evaluation task by providing multi-attributive rating scales for the user also increases the accuracy of decisions [8, 9, 13, 34, 46, 47]. Moreover, Klein and Garcia [28] suggest that crowd evaluation is very helpful in detecting bad ideas, but less so when it comes to distinguishing medium or good ideas from really excellent proposals. Research also finds that facilitators of OI processes need to consider an appropriate level for users' cognitive load [9, 19]. Particularly looking at idea evaluation, there seems to occur a trade-off between accuracy and the effort users have to put into idea evaluation [60, 36]. Moreover, many studies stress the importance of the provision of rewards, incentives and other motivating elements for users [16, 34, 49, 54, 66]. For instance, users might already be inclined to participate because they can gain access to the knowledge of experts and peers [34].

Based on the results of our study, we propose a framework that reflects the current state of research (see Figure 1). The framework is based on our concept matrix (see Table 3) and includes all columns except for the study methodology, which is common across the IS discipline. The framework provides readers with a model that describes a typical OI process flow, allowing researchers to locate prior studies and structure future work more easily. It illustrates that both the sphere for the application as well as the sources of information provide the basis for an OI system. The sphere describes whether an academic, public or corporate agent is the facilitator of the OI process. This facilitator decides which source to address. Sources can either be coming from an internal crowd (such as employees) or external crowd (e.g., customers) or experts, like innovation managers or board members. The OI system itself represents an IT artifact. Researchers have to decide whether they seek to investigate full OI systems or only some parts (i.e., models, principles or methods [20, 43]). Facilitators engage their users in idea generation and/or evaluation processes. In many cases, these processes are

interactive and involve user collaboration. Research investigating OI analyzes the above mentioned processes by assessing the quality, efficiency or user motivation. In what follows, we will use this framework and our concept matrix as the basis to discuss prior and identify promising areas for future research.

5 Discussion and Future Research

The finding that research on OI has most recently gained new traction underlines the timely importance of our research. Considering the vast amount of studies from various backgrounds – including many case studies –OI can arguably be considered as an important and well established means to create business innovations. In terms of idea evaluation, our study points out that researchers mostly measured the accuracy of user ratings in comparison to the evaluation of an expert committee. Though very practical, this method is also highly subjective as it depends on the expert selection and might be biased due their predispositions (e.g., having managers of a company evaluate suggestions for improvement by employees [28]). This makes the reproduction of research very difficult. Despite this disadvantage, it is a fairly common method and very suitable as many studies were case-specific and, thus, might depend on inside-knowledge from selected experts to better grasp the value of proposals.

Moreover, our literature review includes only one study that focused on the efficiency of the idea generation process [29]. However, as many firms use OI engagements, it is their employees who use the platforms for ideation. Thus, managers need to be aware of an efficient process structure in order to save valuable resources. Accordingly, one area for future research could be the efficiency of processes in idea generation. For instance, the researched we reviewed stressed that proposals are often redundant [9, 28, 46-47]. Thus, finding methods to limit similarity of ideas – for instance, through issue-based information systems – might be an interesting starting point.

Furthermore, we did not find any study that evaluated whether an internal crowd might be more accurate and efficient in delivering innovative solutions than an external crowd and vice versa. This might be another avenue for future research.

We find a number of studies analyzing idea evaluation process efficiency [e.g., 46, 8, 28, 14, 5]. However, we notice that studies on rating scales and voting techniques often decided to isolate effects triggered by social influence. For instance, both Riedl et al. [47] as well as Klein and Garcia [28] asked participants to evaluate ideas in settings where they were unable to see previous ratings by other users in order to avoid information cascades. However, in practice, users' decisions could be swayed by peer opinions [46-47, 67]. This is intuitive when looking at information sharing in social networks and, even more so, in idea markets, where facilitators explicitly build on the users' collaborative exchange of evaluations (i.e., trading activity) to derive the best ideas [32, 51, 38]. Thus, future research could investigate the robustness of different rating scales against information cascades and related effects in order to reflect more realistic conditions of OI systems.

While many studies evaluated users' motivation to participate in an OI contest, analyzing motivation was often more of a by-product rather than the main focus of any study. However, as OI becomes more professionalized, on one hand, and more of a

standing, long-term process, on the other, Gassmann [17] note that motivating users becomes more challenging. Thus, future research could focus on this area as well. For instance, some studies were conducted using gamified systems, which builds on rewards, badges and other attributions to drive user motivation [49, 66, 16, 54]. However, as gamification does not necessarily lead to long-term motivation [16], future research could focus on longitude studies.

Finally, our literature review finds that extant research produced numerous models and systems for OI. However, they have rarely been adopted by other researchers. This might be related to the highly specific context to which OI processes are used for, making it difficult to generalize models and associated findings. On the other hand, idea generation, collaboration and evaluation represents a common theme in Information Systems research. There are also a number of professional OI platform providers (e.g., Hyve, Exago). Although we acknowledge the holistic approach undertaken by many studies developing a complete OI system from the ground up, we encourage future research to focus on more specific areas by contributing to the cumulative building of design theories. Gregor and Jones [20] criticized the constant re-invention of artifacts and methods under new labels, which we see happening in the literature of OI as well. The concept matrix and framework of our literature review can help to guide these approaches by providing a unified, structured approach.

This study needs to be considered against its limitations. We set strict research boundaries, following Weber and Watson [60]. Yet, this led to the exclusion of some studies from our final analysis. We might have missed some studies because they did not include the specific keywords in their title or meta-data and were not referenced by the studies we analyzed. For instance, idea evaluation can be framed as a group decision, which is a large area of IS research but is not necessarily conducted within an OI context. Furthermore, we found only few studies framing OI in the public sphere. However, as modern governments begin to involve their citizens more often in processes such as participatory budgeting [39], future research could investigate how such engagements resemble OI.

6 Conclusion

In summary, this study developed a model for research on idea generation, collaboration and evaluation in OI processes by conducting a structured literature review. We demonstrated that OI remains an emerging interdisciplinary research field, which is gaining new attention in the scientific community. Our analysis suggested that the majority of prior research investigated OI by means of case studies, often proposing an IT artifact. Our study contributes to the Information Systems literature by providing a unified, structured framework that can help to reflect and classify past research and guide future studies on OI. We also contribute to the IS literature by identifying several research gaps, which could build the basis for future research. This includes comparisons between internal and external crowds, a call for the investigation of phenomena such as information cascades, and our critique of a very limited cumulative knowledge building.

Considering the recent changes in the OI environment (e.g., accessibility for SMEs, employee-driven innovation, and professional OI platform providers), OI will most

likely remain a rapidly emerging field for research. Our literature review also includes some implications for practitioners, guiding the design of future OI systems. For instance, we highlight the well-proven efficiency of multi-attributive rating scales, the acknowledgement of the users' cognitive load and the emphasis on rewards, incentives and other motivating components.
Going forward, it will be interesting to see, which mechanisms will yield the most creative and valuable ideas while still ensuring appropriate levels of effectiveness and user motivation in the long-run.

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References

1. ABS: Academic Journal Guide 2015, (2015).
2. Adamczyk, S., Bullinger, A.C., Möslein, K.M.: Innovation Contests: A Review, Classification and Outlook. Creat. Innov. Manag. 21, 335–360 (2012)
3. Australian Council of Professors and Heads of Information Systems: ACPHIS: Recommended IS Conferences, http://www.acphis.org.au/index.php/is-conference-ranking.
4. Bailey, B.P., Horvitz, E.: What's your idea? A case study of a grassroots innovation pipeline within a large software company. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 2065–2074. , Atlanta (2010).
5. Bao, J., Sakamoto, Y., Nickerson, J. V.: Evaluating Design Solutions Using Crowds. In: Proceedings of the Americas Conference on Information Systems (2011).
6. Bayus, B.L.: Crowdsourcing New Product Ideas over Time: An Analysis of the Dell IdeaStorm Community. Manage. Sci. 59, 226–244 (2013).
7. Björk, J., Magnusson, M.: Where do good innovation ideas come from? Exploring the influence of network connectivity on innovation idea quality. J. Prod. Innov. Manag. 26, 662–670 (2009).
8. Blohm et al.: Does Collaboration among Participants Le ad to Better Ideas in IT-based Idea Competitions? An Empirical Investigation. In: Proceedings of the Annual Hawaii International Conference on System Sciences (2010).
9. Blohm, I., Riedl, C., Leimeister, J.M., Krcmar, H.: Idea Evaluation Mechanisms for Collective Intelligence in Open Innovation Communities: Do Traders Outperform Raters? In: Proceedings of the International Conference on Information Systems (ICIS) (2011).
10. Boudreau, K.J., Lacetera, N., Lakhani, K.R.: Incentives and Problem Uncertainty in Innovation Contests: An Empirical Analysis. Manage. Sci. 57, 843–863 (2011).
11. Bullinger, A.C., Neyer, A.-K., Rass, M., Moeslein, K.M.: Community-based innovation contests: Where competition meets cooperation. Creat. Innov. Manag. 19, 290–303 (2010).
12. Chesbrough, H.W.: Open Innovation: The New Imperative for Creating and Profiting from Technology. (2003).
13. Ciriello, R.F., Richter, A., Schwabe, G.: Designing an Idea Screening Framework for Employee-driven Innovation. In: Proceedings of the Annual Hawaii International Conference on System Sciences. pp. 4262–4271 (2016).

14. Dean, D.L., Hender, J.M.: Identifying Quality, Novel, and Creative Ideas: Constructs and Scales for Idea Evaluation. J. Assoc. Inf. Syst. (2006).
15. Di Gangi, W.: Steal my idea! Organizational adoption of user innovations from a user innovation community: A case study of Dell IdeaStorm. Decis. Support Syst. (2009).
16. Feldmann, N., Adam, M., Bauer, M.: Using serious games for idea assessment in service innovation. In: Proceedings of the Europ. Conf. on Inf. Systems (ECIS), Tel Aviv (2014).
17. Gassmann, O., Enkel, E., Chesbrough, H.: The future of open innovation. R D Manag. 40, 213–221 (2010).
18. Girotra, K., Terwiesch, C., Ulrich, K.T.: Idea Generation and the Quality of the Best Idea. Manage. Sci. 56, 591–605 (2010).
19. Görs, J., Horton, G., Kempe, N.: A Collaborative Algorithm for Computer-Supported Idea Selection in the Front End of Innovation. In: Proceedings of the Annual Hawaii International Conference on System Sciences. pp. 217–226 (2012).
20. Gregor, S., Jones, D.: The anatomy of a design theory. J. Assoc. Inf. Syst. 8, 312–335 (2007).
21. Gressgård, L.J., Amundsen, O., Merethe Aasen, T., Hansen, K.: Use of information and communication technology to support employee-driven innovation in organizations: A knowledge management perspective. J. Knowl. Manag. 18, 633–650 (2014).
22. Horton, G., Goers, J., Knoll, S.W.: How Not to Select Ideas for Innovations: A Critique of the Scoring Method. In: Proceedings of the Annual Hawaii International Conference on System Sciences. pp. 237–246 (2016).
23. Howe, J.: The Rise of Crowdsourcing. Wired Mag. 14, 1–5 (2006).
24. Hrastinski, S., Kviselius, N.Z., Ozan, H., Edenius, M.: A review of technologies for open innovation: Characteristics and future trends. In: Proceedings of the Annual Hawaii International Conference on System Sciences (2010).
25. Hutter, K., Hautz, J., Füller, J., Mueller, J., Matzler, K.: Communitition: The tension between competition and collaboration in community-based design contests. Creat. Innov. Manag. 20, 3–21 (2011).
26. Jung, J.H., Schneider, C., Valacich, J.: Enhancing the Motivational Affordance of Information Systems: The Effects of Real-Time Performance Feedback and Goal Setting in Group Collaboration Environments. Manage. Sci. 56, 724–742 (2010).
27. Kathan, W., Hutter, K., Füller, J., Hautz, J.: Reciprocity vs. Free-Riding in Innovation Contest Communities. Creat. Innov. Manag. 24, 537–549 (2015).
28. Klein, M., Garcia, A.C.B.: High-speed idea filtering with the bag of lemons. Decis. Support Syst. 78, 39–50 (2015).
29. Kornish, L.J., Ulrich, K.T.: Opportunity Spaces in Innovation: Empirical Analysis of Large Samples of Ideas. Manage. Sci. (2011).
30. Kristensson, P., Gustafsson, A., Archer, T.: Harnessing the Creative Potential among Users. J. Prod. Innov. Manag. (2004).
31. Lakhani, K.R., Jeppesen, L.B.: Getting unusual suspects to solve R&D puzzles. Harv. Bus. Rev. 85, 30–32 (2007).
32. Lauto, G., Valentin, F.: How preference markets assist new product idea screening. Ind. Manag. Data Syst. 116, 603–619 (2016).
33. Lee, H., Seo, S.: What Determines an Agreeable and Adoptable Idea? : A Study of User Ideas on MyStarbucksIdea.com. In: Proceedings of the Annual Hawaii International Conference on System Sciences. pp. 3207–3217 (2013).
34. Leimeister, J.M., Huber, M., Bretschneider, U., Krcmar, H.: Leveraging Crowdsourcing: Activation-Supporting Components for IT-Based Ideas Competition. J. Manag. Inf. Syst. 26, 197–224 (2009).
35. Luo, L., Toubia, O.: Improving Online Idea Generation Platforms and Customizing the

Task Structure on the Basis of Consumers' Domain-Specific Knowledge. J. Mark. 79, 100–114 (2015).
36. Magnusson, P.R., Netz, J., Wästlund, E., W??stlund, E.: Exploring holistic intuitive idea screening in the light of formal criteria. Technovation. 34, 315–326 (2014).
37. Muller, M., Geyer, W., Soule, T., Daniels, S., Cheng, L.-T.: Crowdfunding inside the Enterprise: Employee-Initiatives for Innovation and Collaboration. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 503–512 (2013).
38. Natalicchio, A., Messeni Petruzzelli, A., Garavelli, A.C.: A literature review on markets for ideas: Emerging characteristics and unanswered questions. Technovation. 34, 65–76 (2014).
39. Niemeyer, C., Wagenknecht, T., Teubner, T., Weinhardt, C.: Participatory Crowdfunding: An Approach towards Engaging Employees and Citizens in Institutional Budgeting Decisions. In: Proceedings of the Annual Hawaii International Conference on System Sciences. pp. 2800–2808 (2016).
40. Palvia, P., Leary, D., Mao, E., Midha, V., Pinjani, P., Salam, A.F.: Research Methodologies in MIS: An Update. Commun. Assoc. Inf. Syst. 14, 526–542 (2004).
41. Pashkina, E., Indulska, M.: Where are the Ideas?: External Idea Acquisition. In: Proceedings of the Australasian Conferences on Information Systems. p. Paper 85 (2011).
42. Pedersen, J., Kocsis, D., Tripathi, A., Tarrell, A., Weerakoon, A., Tahmasbi, N., Xiong, J., Deng, W., Oh, O., De Vreede, G.J.: Conceptual foundations of crowdsourcing: A review of IS research. In: Proceedings of the Annual Hawaii International Conference on System Sciences (2013).
43. Peffers, K., Tuunanen, T., Rothenberger, M., Chatterjee, S.: A design science research methodology for information systems research. J. Manag. Inf. Syst. 24, 45–77 (2007).
44. Piller, F.T., Walcher, D.: Toolkits for idea competitions: A novel method to integrate users in new product development. R D Manag. 36, 307–318 (2006).
45. Poetz, M.K., Schreier, M.: The value of crowdsourcing: Can users really compete with profession als in generating new product ideas? J. Prod. Innov. Manag. 29, 245–256 (2012).
46. Riedl, C., Blohm, I., Leimeister, J.M., Krcmar, H.: Rating Scales for Collective Intelligence in Innovation Communities: Why Quick and Easy Decision Making Does Not Get it Right. In: Proceedings of the 31st International Conference on Information Systems, St. Louis (2010).
47. Riedl, C., Blohm, I., Leimeister, J.M., Krcmar, H.: The Effect of Rating Scales on Decision Quality and User Attitudes in Online Innovation Communities. Int. J. Electron. Commer. 17, 7–36 (2013).
48. Sawhney, M., Verona, G., Prandelli, E.: Collaborating to create: The Internet as a Platform for Customer Engagement in Product Innovation. J. Interact. Mark. (2005).
49. Scheiner, C.W.: The motivational fabric of gamified idea competitions: The evaluation of game mechanics from a longitudinal perspective. Creat. Innov. Manag. 24, 341–352 (2015).
50. Siemon, D., Rarog, T., Robra-Bissantz, S.: Semi-Automated Questions as a Cognitive Stimulus in Idea Generation. In: Proceedings of the Annual Hawaii International Conference on System Sciences. pp. 257–266 (2016).
51. Soukhoroukova, A., Spann, M., Skiera, B.: Sourcing, filtering, and evaluating new product ideas: An empirical exploration of the performance of idea markets. J. Prod. Innov. Manag. 29, 100–112 (2012).
52. Stieglitz, S., Hassannia, S.: Idea Generation by Employees and External Participants in Innovation Competitions. In: Proc. of HICCS, pp. 4272–4281 (2016).
53. Terwiesch, C., Xu, Y.: Innovation Contests, Open Innovation, and Multiagent Problem

Solving. Manage. Sci. 54, 1529–1543 (2008).
54. Toubia, O.: Idea Generation, Creativity, and Incentives. Mark. Sci. 25, 411–425 (2006).
55. Toubia, O., Florès, L.: Adaptive Idea Screening Using Consumers. Mark. Sci. 26, 342–360 (2007).
56. van Aken, J.E.: Management Research Based on the Paradigm of the Design Sciences: The Quest for Field-Tested and Grounded Technological Rules. J. Manag. Stud. 41, 219–246 (2004).
57. Wagenknecht, T., Filpe, R., Weinhardt, C.: Towards a Research Framework of Computer-Supported Organizational Participation. Springer Lect. Notes Comput. Sci. Electron. Particip. (2016).
58. Walter, T.P., Back, A.: Towards Measuring Crowdsourcing Success: An Empirical Study on Effects of External Factors in Online Idea Contests. In: MCIS 2011 Proceedings (2011)
59. Walter, T.P., Back, A.: A text mining approach to evaluate submissions to crowdsourcing contests. In: Proceedings of the Ann. Hawaii Intl. Conference on System Sciences (2013).
60. Webster, J., Watson, R.T.: Analyzing the Past to Prepare for the Future: Writing a Literature Review. MIS Q. 26, xiii–xxiii (2002).
61. West, J., Bogers, M.: Leveraging External Sources of Innovation: A Review of Research on Open Innovation. J. Prod. Innov. Manag. 31, 814–831 (2013).
62. Wu, S.-C., Fang, W.: The effect of consumer-to-consumer interactions on idea generation in virtual brand community relationships. Technovation. 30, 570–581 (2010).
63. Xu, A., Bailey, B.P.: A Reference-Based Scoring Model for Increasing the Findability of Promising Ideas in Innovation Pipelines. In: Proceedings of the ACM Conference on Computer Supported Cooperative Work. pp. 1183–1186. , Seattle (2012).
64. Yu, L.L., Nickerson, J. V.: Generating creative ideas through crowds: An experimental study of combination. In: Proceedings of the International Conference on Information Systems (ICIS). p. Paper 21 (2011).
65. Yücesan, E.: An efficient ranking and selection approach to boost the effectiveness of innovation contests. IIE Trans. 45, 751–762 (2013).
66. Zimmerling, E., Höflinger, P.J., Sandner, P., Welpe, I.M.: Increasing the Creative Output at the Fuzzy Front End of Innovation – A Concept for a Gamified Internal Enterprise Ideation Platform. In: Proceedings of the Ann. Hawaii Intl. Conf. on Sys. Sci. pp. 837–846 (2016).
67. Wagenknecht, T., Crommelinck, J., Teubner, T., Weinhardt, C.: When Life Gives You Lemons: How rating scales affect user activity and frustration in collaborative evaluation processes. In: 13th International Conference on Wirtschaftsinformatik (2017).